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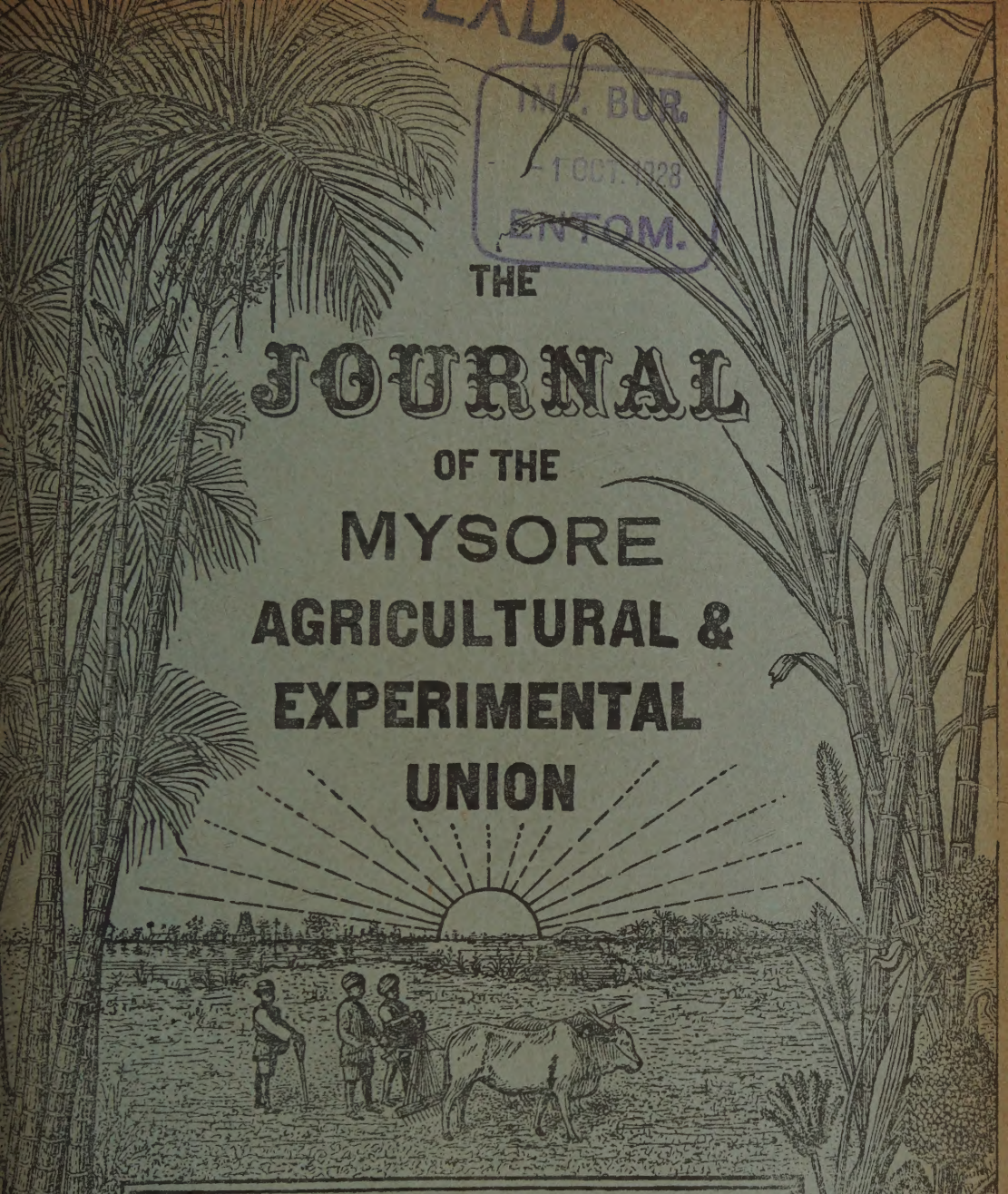

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By A. K. Yegnanarayana Iyer, M.A., Dip. in Agri. (Cantab.), N.D.D., F.C.S.

Research Work on the Soil during the last 25 Years.—
By Sir E. J. Russell, F.R.S., D.Sc.

THE JOURNAL OF THE MYSORE AGRICULTURAL AND EXPERIMENTAL UNION.

A quarterly magazine devoted to the advancement of Agriculture and published by the Mysore Agricultural and Experimental Union.

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A Note on the Consolidation of Holdings in Mysore.

BY

A. K. Yegnanarayana Iyer, M.A., Dip. in Agri. (Cantab.), N.D.D., F.C.S.,

Deputy Director of Agriculture in Mysore.

I. Introductory.

The subject of the fragmentation of holdings and the need for some measure of consolidation has occupied public attention for some years recently as one of the main lines of agricultural improvement. The smallness of individual holdings and the small and scattered fields of which even such holdings are composed are certainly very characteristic features of Indian Agriculture and cannot fail to attract the notice of even casual observers. The evils of such a state of affairs and the great and substantial improvement that may result if it is remedied are more or less well recognized and the only question has been one of ways and means, as to how best to effect such consolidation in practice taking into consideration the existing conditions regarding ownership of land, the law of inheritance, and the system of farming and the general level of rural life in the country. In Mysore the conditions in this respect are not very different from those prevailing elsewhere, and the methods of consolidation suggested by those who have studied the subject and the difficulties attendant upon any such scheme may be taken to apply more or less to the conditions in our State also. Notable contributions to the subject

have been made by Prof. Stanley Jevons in the United Provinces, and Mr. Moreland, late Director of Agriculture in the United Provinces, by Dr. Mann and his pupils in the Bombay Presidency and by Mr. Keatinge, late Director of Agriculture, Bombay. The notes submitted to and the discussions in the Board of Agriculture at Poona, a paper by Mr. Burt read before the Indian Science Congress and a very exhaustive and valuable report drawn up by a Committee appointed by H. H. the Gaekwar of Baroda to go into the subject and suggest suitable measures, all form important literature on the subject. In 1916 the subject came up for discussion in the Bombay Legislative Council and the proceedings in that council afford an interesting variety of opinions on the question, looked at from several points of view. The order of the Government of Madras on the results of certain experimental work in this connection attempted by one of their Settlement Officers contains some very decided opinions held by that Government on the subject. Work of a positive character has been accomplished in the Punjab, where through the efforts of Mr. Calvert, Registrar of Co-operative Societies, the agency of the co-operative societies has been made use of successfully to bring about consolidation in several areas on a large scale. On the other hand the attempts referred to of the Government of Madras who had ordered one of their Settlement Officers to undertake the work during the course of the settlement operations resulted only in failure. In Mysore the subject has been discussed by the Board of Agriculture, and a brief note of a somewhat general scope has also been published by Dr. Coleman. As far as I know no study of the question as it relates to the circumstances of Mysore has been made. In the following pages I have attempted to bring together the notes of a study which I have been able to make with particular reference to conditions in our State in the hope that it may be found useful as a basis for any action that may be deemed fit to take.

II. Nature and Extent of Fragmentation in Mysore.

Before going into the subject of the methods by which any measure of consolidation can be brought about, it will be well to describe in some detail the existing state of affairs in the State. The subject has to be dealt with under two main divisions, *viz.*, (1) the actual size of individual holdings and (2) the amount of fragmentation such holdings may exhibit or the number, area and location of

the fields of which such holdings may be made up. To take the second first :—

The size of the fields of which a holding is composed varies greatly firstly with the character of the cultivation, that is to say, whether the land is dry, wet, or garden, which are the three recognized classes of cultivation in the State. In the first case the fields are usually large in size going even up to 10 to 15 acres in the case of the black cotton soils and averaging about a third of this size in the case of the red sandy or loamy soils which form the bulk of the area in the State and in any case seldom less than an acre in extent.

In the case of wet lands the size of the fields is exceedingly small owing principally to the fact that the cultivation of paddy necessitates flat and level fields suitable for impounding water to a height of about 3 or 4 inches in the field itself. Even where the land is level more or less as is the case under tank irrigation, fields are seldom made larger than about $\frac{1}{4}$ an acre. In the case of the extensive paddy areas under the river channels where the land is as a rule steep, the plots have to be laid out into terraces composed of often ridiculously small fields of even 1/40 of an acre. Somewhat larger fields are possible but such terracing will involve a higher expenditure than the *raiyats* can afford ; to a certain extent the thin and gravelly soils will not also permit the cutting required for larger fields without seriously impairing the suitability of the soil. In these tracts, therefore, these diminutive fields are practically unavoidable and even where all the fields in a block may form part of a single holding, for the reason mentioned, their consolidation so as to avoid this minute division will be impossible. On the Government Experimental Farm in Nagenahalli, Mysore District, which is typical of the channel tract, it has been attempted to avoid as far as possible such small fields as the raiyat would have them cut up into and to secure as large fields as the conditions will permit. Cutting had to be made sometimes as deep as 4 feet, two contiguous fields differing in level to that extent. Even then it has not been found possible to enlarge the size of the fields beyond about 4 guntas or 1/10 an acre which is by no means a good sized field although a great improvement upon the *raiyat's* divisions. *The accompanying plan which represents one of the ranges into which the farm is divided shows the areas

* The plan referred to together with a few others are omitted in these columns.

of the individual plots and their levels. It will be noticed that the difference in level between the top and the bottom plot is as much as 13 feet, the total linear distance from end to end being only 150 feet. Deeper cuttings to secure larger fields and extinguish the numerous dividing bunds will only expose either bare rock or soil too gravelly to cultivate. On fairly level land such as forms the cultivated area (*achakat*) under tanks, small fields are the result of the exigencies of paddy cultivation and are readily convertible into larger fields by the removal of the bunds separating the plots. As a matter of fact these bunds are often only temporary being removed when the cultivation of sugarcane or other similar crop follows the paddy, provided, of course, contiguous fields belong to the same owner. In the channel areas, at present at least, water for irrigation is available only for six months in the year ; the same is the case even under some of the tanks ; the cultivation of sugarcane is out of the question and consequently the small paddy flats are the rule. It is these minutely small paddy flats that draw one's attention strikingly to this question at all, but it will be seen that on the whole such division is unavoidable.

In regard to garden or *bagayat* cultivation, where it refers to the mixed gardens of cocoanuts, arecanuts, plantain and similar crops, the areas belonging to individuals are as a rule small. The small sized individual areas are, however, due to the fact that they form the most valuable lands in the village in which, at the outset at least, each householder had a strip. Ownership is clung to with great tenacity and gardens are seldom parted with except under dire necessity. The gardens take from eight to twelve years to establish and once brought into bearing condition they last for hundreds of years with proper attention to the local system of cultivation. They tend, therefore, to remain in the hands of individuals or families for long periods if not of generations. It is also the case that the cultivation of such *bagayat* whether in the areca gardens of the malnad or the areca *cum* cocoanut and other mixed plantations of the plains, is very different from ordinary arable field crop cultivation ; they are mostly self-contained units, securely fenced, with their own irrigation well, making each man very little dependent upon his neighbours ; cultivation is all by hand implements such as digging and hoeing and the use of even the plough or other ordinary bullock implements is out of the question, much less the use of any large

labour-saving outfits. The disadvantage of small areas is, therefore, not so great in the case of *bagayat* cultivation as it is in the case of the dry or wet cultivation dealt with above.

The rules relating to the division of land into survey numbers prescribe the minimum areas for each of the three classes of cultivation, and these rules which primarily have in view fields of such size as will be required for proper cultivation take note also of the peculiarities of the cultivation on each of the classes. The areas prescribed for the guidance of survey officers are as given below :—

District	Dry	Wet	*Bagayat*	Coffee	
Bangalore	4	1	½	..	Acres.
Kolar	4	1	½	..	„
Tumkur	4	1	½	..	„
Mysore	4	1	½	..	„
Hassan	4	1	¼	15	„
Kadur	5	1	¼	15	„
Shimoga	5	1	¼	15	„
Chitaldrug { Black	10	1	½	..	„
Chitaldrug { Red	6	..	..	..	„

There is nothing, however, to prevent the cutting up of these into smaller fields whether for the exigencies of cultivation which may be absolutely necessary and unavoidable or from other reasons, and in practice few survey numbers remain undivided.

In order to give a clear idea of the division of holdings, size of fields and other particulars, village maps of certain villages are appended. In each village, the holdings of some five owners selected at random are taken for consideration. In the maps the holding of each man is given a special distinguishing mark and a key is also supplied. The maps give graphically a picture of the present state of affairs in each of the villages. With regard to each of these holders the extent of fragmentation can also be seen from the following tabular statement. The fragmentation is not a mere division into fields or strips of one's own large field but refers to the

actual scattering of the component parts of the holding itself in different places :—

Village	Holder	Dry		Wet		Garden	
		Area	Number of blocks	Area	Number of blocks	Area	Number of blocks
Lingapur	A ..	19	3	..	..	..	..
	B ..	45	3	..	..	..	..
	C ..	13	5	..	..	..	..
	D ..	13	5	..	..	..	..
	E ..	23	4	..	..	..	..
Ganiganakoppal.. ..	A ..	21	5	24	3	..	..
	B ..	13	4	20	3	..	..
	C ..	5	4	11	1	..	..
	D ..	6	3	4	1	..	..
	E ..	24	1	..	..	..	..
Somenahalli	A ..	6	3	..	..	..	..
	B ..	2	1	..	..	..	..
	C ..	18	4	..	..	..	..
	D ..	30	3	..	..	..	..
	E ..	40	10	..	..	..	..
Honnalgere	A ..	3	3	..	..	..	..
	B ..	9	5	..	..	..	..
	C ..	7	9	..	..	..	..
	D ..	3	4	..	..	..	..
	E ..	8	8	..	..	..	..
Kadavagere	A ..	..	..	..	..	8	3
	B ..	..	..	..	..	5	4
	C ..	6	4	14	3	27	7
	D ..	2	1	..	..	5	2
	E ..	4	4	8	3	3	2

As regards fragmentation, it will be noted from the above description that a certain amount of fragmentation is inevitable and should be considered normal under the conditions obtaining in the country. Cultivation being made up of the three well-known kinds, *bagayat* or garden, wet or fully irrigated and dry or depending solely on rainfall and the classification itself being consequently upon the situation of the land in regard to facilities for irrigation water and other natural advantages it follows that areas of each of these three kinds of cultivation in the village are situated in distinct separate blocks from each other, the dry lands especially being far away from the wet and garden blocks. Thus the *bagayat* area is the one nearest to the irrigation tank commencing right from the foot of the tank

bund with irrigation water always available either from the tank or from subsidiary wells in the gardens themselves; further and lower down in the irrigation area are the wet lands on which paddy, sugarcane and other annual crops are grown. These include also the low lying lands liable to be flooded, wet and swampy and so on, on which nothing but paddy can be grown. The uplands, literally high and dry, surrounding the village which form the largest in area of the three are devoted to dry cultivation. Villagers hold a piece of land in each of the three blocks and from the earliest times the distribution of the land in the village has been based upon an equitable division of all the advantages so that each house owns a bit in the garden land, a bit in the wet area and a bit in the dry. Not only in equity but also from an agricultural point of view such distribution should be deemed the most suitable, because under such an arrangement work is provided evenly distributed throughout the year to each holder. It is really founded upon a correct understanding of what an economic holding is. Land has, in recent times, changed hands frequently and the wet and garden lands tend to pass into the ownership of the more wealthy villagers or of the town-dwelling merchants or other non-cultivating capitalist classes. Although this has upset the old arrangement as regards ownership, the cultivation itself is carried on as though no such change in ownership had occurred, the best raiyats cultivating land in all three sections either in their ownership or as cultivating tenants. Furthermore such villages, that is to say, villages commanding a good irrigation tank favouring both *bagayat* and wet cultivation and possessing an adequate area of dry land as well, are the ideal villages agriculturally and wherever possible the old village communities have tried and secured these advantages. The combination of dry cultivation with some kind of irrigated cultivation is such a patently and vitally important feature of successful agriculture in the country that the particular form of fragmentation of one's holdings which is inevitable and a necessary consequence of the arrangement has only to be put up with. Such disadvantages as are incidental to not having one's fields all in one compact block should, in regard to this particular form of fragmentation, be deemed not worthy of consideration.

For the purpose of this discussion, therefore, the wet and dry areas should be taken as distinct classes of holdings and the possibility of

consolidation considered for each of them separately. This indeed is too obvious to be specifically mentioned ; but as the literature relating to the consolidation of holdings which will be useful for one's guidance all relates to countries where the conditions in this regard are entirely different it has not been considered out of place.

Where irrigated cultivation is practised from wells situated in the midst of one's dry lands and not from channel or tank the case is different. Such cases indeed present the most useful scope for the creation of compact holdings ; a dry holding large enough for an average family, which will comprise a few acres commanded by a good irrigation well will serve as an admirable self-contained peasant holding. With the greater attention that may be bestowed by both people and Government on the extension of well cultivation, the survey of underground water sources, the location of suitable sites and the sinking of irrigation wells, the scope for the creation of such holdings will increase and a more favourable atmosphere will also be created for the acceptance of any systematic measure of consolidation.

III. Disadvantages of Fragmentation under Mysore Conditions.

We shall now describe in some detail the disadvantages of the present state of affairs so that we can better appreciate the many-sided improvement that is likely to accrue as the result of a general rearrangement or consolidation of the strips composing the present holdings. With one's fields scattered about as at present the question of fencing one's property becomes either impossible or too prohibitive in cost. Without a proper fence independent farming is impossible ; one has simply to sink to the level of the general system of farming of the village and cannot rise above it or strike out into any improved lines of work. One has to sow the same crops, and the same varieties of them too, as the other villagers do ; for if one sows a variety which matures earlier than the local variety, harvesting and carting the produce through a neighbour's field with a standing crop on it is out of the question ; if it is a later variety the field is open to the havoc of stray cattle, for this will be the only spot of green in the midst of the bare harvested fields. If this is the difficulty in the case of the varieties of even the same crop as is grown by the villagers it is multiplied several-fold if a different crop altogether should be attempted. Even with a fenced field the conditions

in the villages are such that very little protection is obtainable and it must be within the experience of every man who has gone to the village with the idea of starting some independent line of cultivation which he considers more profitable, how difficult and harassing it is to attain even a small measure of protection against the village cattle with the best of fences he could afford to put up. The growing of fodder crops and the keeping of good cattle and sheep, the raising of commercial crops, of orchard or plantation becomes very difficult to attempt and the pioneer usually is beaten and has to give up in despair. Even where a well is sunk intensive cultivation becomes difficult, and oftentimes the area adjoining it is too small to form a sufficient incentive to invest more money, to enclose, to build a farmhouse, improve the well and otherwise start remunerative farming. With a throwing together of the scattered field of one's holding, it is likely even the small and backward holders will feel tempted to enclose their fields and attempt a better scheme of cultivation. At present the obstacles are so great that nothing better is thought of. It is true that very good and successful cultivation is practised in parts of the world such as in parts of Germany, France and in the Channel Islands and in that much talked-of land of agricultural perfection, Denmark, even though fenced fields are not the rule; but the conditions are different, especially in regard to the level of education and standard of life and the profits that have consequently to be wrested out of the land. There is no gainsaying the fact that fenced fields with the owner living in his land connote both in India and elsewhere a much higher level of farming than when the fields are open. A restripping or consolidation will be at least one way of bringing this about.

The time spent in moving one's implements of cultivation in the cultivating season to and from fields far distant from each other is a great waste and acts as another obstacle to quick and timely agricultural operations, and, contrary as it may be to the general belief that the raiyats have no idea of time, none feel this more keenly than they do. The distant fields really are neglected, ploughing, cultivating and sowing are seldom done in time or satisfactorily; and if the nearer fields should have been sown or even well prepared it will be impossible to take manure carts or implements along to the farther fields, except in the villages where it is common to have wide field margins.

In the matter of harvesting again, *raiyats* dread to have to leave their harvested sheaves lie in too many different places for them to have an eye on against thieves. Crop thefts and the lack of proper security are indeed becoming in many villages a very serious obstacle in the way of the growing of commercial crops like sugarcane, potato, plantain, etc.

Many a holding again if its component parts are put together will even in this land of small holdings permit the use of labour-saving implements ; at present there are a large number of fields which will not allow of the use of even the large-scale local appliances such as are used with advantage in the black cotton soil tracts. The introduction of even these will mean a great saving of labour and quicker work ; but as a matter of fact there will be scope for other machines as well, ambitious though they may appear now. The use of tractor ploughs, cultivators and harrows, the use of the larger seed drills, of the cart to replace what now is done largely in headloads and of the reaping machine, these are all bound to come in with the increasing dearth and costliness of agricultural labour. The consolidation of holdings will make the introduction of these more easy both for use by single holders of the larger type or owned co-operatively by others. These remarks apply of course in the main to dry land and not to the wet lands where fields have to be small and in the case of the channel tracts of the Mysore District in different levels also. Even when the holding is large and compact in this particular case owing to the special circumstances of the land and the cultivation the fields cannot be made suitable for anything but small-scale implements. The case of the channel area is of a special class and is dealt with separately. One of the chief draw-backs again in the present arrangement is the lack of field roads or tracks. Fields lie anywhere and anyhow and carting manure or produce is difficult and often not possible at all. In certain districts field margins in dry lands are kept wide for various reasons ; on such situations the difficulty is not so great. As a general rule, however, unless one moves with the crowd so to speak and carries out his operations simultaneously with his neighbours the difficulty will be insurmountable; carting will be out of the question and transport can be only by headloads. Any scheme of consolidation will certainly take note of this serious difficulty and provide the needed remedy. At present it is certainly not that the *raiyat*

does not feel it as a great draw-back but the utter helplessness of the situation makes him acquiesce in it with absolute resignation. The case is particularly bad in this regard on the wet lands of the channel tracts.

The erecting of a homestead on the land for the *raiyat* to live in and attend to his cultivation, with the manifold advantages which such a system implies, will also become possible only when a compact holding can be brought into being. Such a change will for one thing remove the immense waste of labour now going on on account of the *raiyat*, his family, labourers, and cattle, carts and implements having to move from one distant field to another; close supervision will become possible, greater protection can be had against petty thefts and damage by stray cattle, the labour will be more easy and become almost doubly effective, the land will be better fertilized and both the *raiyat* and his womenfolk and children will be in healthier surroundings. The importance and the great advantage of the *raiyat* living on his land can hardly be exaggerated. It is only a question if the *raiyat* will move out. I am of opinion that in the large majority of cases they will do so cheerfully when holdings of the proposed kind come into being. In many of the *malnad* villages the practice of living in one's own holding already exists and the *malnad* village is only a collection of many such homesteads. In the *maidan* districts also where there are cocoanut and arecanut gardens especially the former as in the case of the Tiptur and the adjoining taluks it is not uncommon for *raiyats* to live in the gardens if not permanently at least as in a garden house. There are a large number of people in other villages especially where there may be some kind of well cultivation who, when plague broke out in the village, moved temporarily into structures put up for the time near their wells and fields but having found the arrangement extremely advantageous agriculturally have decided to live there permanently either with the whole or part of their family. Provided there is no difficulty for domestic water-supply it will be found that in these days villagers evince a keen disposition to move on to and live in their lands away from the village; and were it not, I think, for the fact that such moving out is not freely permitted by the Revenue authorities one would have seen considerable migration of the kind. The rule which thus discourages this excellent practice is probably a relic of the time when the conditions were very different but in the

interests of efficient farming deserves to be modified. However, what we are concerned with here is the evidence to show that people will move out and live on their lands even at present with conditions not altogether favourable and that they can be, therefore, expected to do so more eagerly when consolidation comes in. The consolidation may, therefore, be confidently expected to lead to the system of *raiyats* living on the land, to the great advantage and improvement of the land.

The increase in the cultivated area which will result by consolidation on account of the removal of a large number of dividing bunds, the straightening of others and the re-alignment of irrigation channels, drainage ditches and so on is also one of the chief considerations in favour of consolidation. In Japan especially where consolidation work has now been going on for some years, on the basis of the area covered so far, the cultivated area is expected to increase by this means by 400,000 hectares or 8 per cent over the total for the Empire, while for many individual areas the increase has been very much greater ; such increase has indeed been so material that the value of the increased area has been found to cover the cost of consolidation in several areas. It is true that in Mysore also considering the often absurdly small plots into which wet land is divided, an equally material increase in the cultivated area can be made available by the throwing together of the small plots. Calculating on the basis of the Government Farm at Nagenahalli it may be estimated that such regrouping into plots of about $\frac{1}{4}$ an acre will result in about 10 per cent over the existing area. There are wet lands under tanks on which division has been so great and cultivation so much neglected, that increase up to even 25 per cent can be attained. As the result of absentee landlordism and the leasing of the wet lands to *raiyats* who own large areas of dry lands of their own, bunds have been made large enough to serve the purpose of affording green grass to *raiyats'* cattle, in great contrast with the narrow bunds almost reduced to a vanishing point which is the rule where paddy cultivation is carried on by the owners themselves or under their direct supervision. It is sometimes humorously remarked in such neglected villages that you cannot see the fields for the bunds. In one village studied, the area of the fields was 30 acres while that of the whole block was 40, giving 10 acres as the area taken up by the bunds. The partition of lands on the death of the father

amongst the sons has also carried matters to a ridiculous extreme in many cases. But when all allowance is made for these facts, it must be stated that the evil at the present time at any rate has not assumed any serious proportions. As already explained wet land fields even on the level have to be kept within the requirements of the paddy cultivation, and under the extensive channel-irrigated lands the need for terracing is a further and unavoidable factor which necessitates such small plots. Very little, therefore, of any appreciable advantage can be effected. In the case of the dry lands even less importance has to be attached to the above consideration of an increase in the cultivated area. The fields for one thing are fairly large and even after restripping, the areas of individual fields are not likely to be increased. Furthermore, dry land field bunds at the present time are very wide, sometimes even surprisingly so, the reason assigned being the need for some grazing for the *raiyats*' cattle and for room for carts to pass. There is not so much scramble for dry land as to induce *raiyats* to consider this an evil. It is not a case of the highly intensive cultivation practised in Japan where cultivation is practically throughout the year, the pressure on the lands is immense and not even an inch of ground can be allowed to lie waste. We are still in spacious days and the increase in area due to consolidation has not assumed sufficient importance to serve as a deciding factor.

On the other hand, such consolidation as can be effected will have to result in a certain loss of cultivated area. In the channel tracts there is almost a total absence of roads and even pathways in the paddy blocks. There is no provision for independent irrigation or drainage apart from that of the block as a whole. Water from the upper fields must pass through the lower ones successively until the bottom of the valley is reached. From the beginning to the end of the crop season a continuous stream flows from the top to the bottom and no *raiyat* is free to cut out or otherwise regulate the water much as he may desire it without infringing the right of the *raiyat* above or the *raiyat* below. When it is remembered that even produce has to be removed from the threshing-floor to the village on the backs of pack donkeys it will be realized how exceedingly difficult it should be to cart manure, seeds or seedlings ; and if for any reason anyone should be behindhand with his work it becomes exceedingly difficult and expensive even to finish the transplanting.

Any scheme of consolidation in this tract should have for its primary aim the provision of suitable roads, irrigation and drainage ditches independently for separate holdings running down from the channel down to the bottom of the valley. Measures of consolidation here will have to take note of all the circumstances which will certainly mean a certain amount of reduction in actual area. The improvement will, however, be such that the land will increase in value more than enough to make up for the loss in area.

IV. Size of Holdings in Mysore as Compared with Certain Other Countries.

Coming now to the actual size of the individual holdings in the State we shall first take up the specific cases of the villages already considered in regard to the fragmentation of the holdings ; we find that as regards the size of the individual holdings the condition is as below :—

Village Somenahalli.—The dry area of this village comprises 561 acres which are divided between 165 holders giving an average of 3½ acres per holder. The wet lands comprise 42 acres which are divided between 56 holders giving an average of ¾ acre per holder.

Village Honnalgere.—The dry lands here comprise 912 acres in the possession of 268 holders which gives an average of 3·4 acres per holder, while the wet lands comprise 73 acres between 112 holders giving an average of ·6 acre of wet land per holder. The village has also 102 acres of *bagayet* owned by 118 holders, which gives an average of about an acre of *bagayet* per holder.

Village Ganiganakoppal.—This village comprises 127 acres of dry land owned by 20 holders giving an average of 6¼ acres per holder, and the wet lands comprise 103 acres owned by 21 holders giving an average of about 4½ acres per holder. The holdings may be also classified according to the size and the number of holders in each class as below :—

	Dry	Per cent of total holdings	Wet	Per cent of total holdings
Below 2 acres	3	15	8	38 (about)
Between 2 and 4 acres	4	20	8	38
„ 4 „ 6 „	7	35	3	14
„ 6 „ 8 „	3	15	0	0
„ 8 „ 10 „	0	0	0	0
„ 10 „ 12 „	0	0	1	5
„ 12 „ 14 „	1	5	0	0
„ 14 „ 16 „	0	0	0	0
„ 16 „ 18 „	0	0	0	0
„ 18 „ 20 „	0	0	0	0
Above 20 .. „	2	10	1	5

Of the 31 holders of land in this village only 13 holders possess both wet and dry land while the remaining 18 holders possess only dry land or only wet land.

Village Nanjapur.—This is a purely dry land village containing 440 acres divided among 67 holders. The average size of the holding is, therefore, $6\frac{1}{2}$ acres. The number of holdings classified according to sizes with the number of holders in each class is as below, from which the size of the real average may be judged :—

		Per cent of total holdings
Below 2 acres	15	22 (about)
Between 2— 4 acres	17	25
„ 4— 6 „	13	20
„ 6— 8 „	7	11
„ 8—10 „	4	6
„ 10—12 „	3	4
„ 12—14 „	2	3
„ 14—16 „	2	3
„ 16—18 „	0	0
„ 18—20 „	2	3
Above 20 „	2	3

Village Kadavegere.—This is a large village possessing very valuable *bagayat* lands, wet lands and dry lands. The fragmentation

of a few individual holdings in each of the three classes of land has already been given.

As regards the size of individual holdings, taking the *bagayat* holdings, this comprises an area of 187 acres divided among 58 holders giving an average of 3¾ acres per holder. The wet land likewise comprises 133 acres divided among 62 holders which gives an average of about 2 acres per holder. The dry land area comprises 476 acres among 58 holders giving an average of 8¼ acres per holder.

The classification of the holdings according to the sizes and the number of holders in each class will be seen from the following table :—

	Wet		Dry		Garden	
	Number in each class	Per cent to total holdings	Number in each class	Per cent to total holdings	Number in each class	Per cent to total holdings
Below 2 acres	31	50	16	..	28	48
Bet. 2 and 4 acres..	20	32	8	..	15	26
Bet. 4 and 6 „	3	5	9	..	10	18
Bet. 6 and 8 „	8	13	6	..	1	2
Bet. 8 and 10 „	..	..	7	..	2	3
Bet. 10 and 12 „	..	..	5	..	2	3
Bet. 12 and 14 „	..	..	3	..	..	..
Bet. 14 and 16 „	..	..	4	..	..	..
Bet. 16 and 18 „	..	..	1	..	..	..
Bet. 18 and 20 „	..	..	0	..	..	..
Above 20 „	..	..	5	..	..	..

Among the 102 holders of land in the village only 23 possess all three kinds of land *i.e.*, *bagayat*, wet and dry, and others possess only holdings of one kind or two kinds, thus 13 hold *bagayat* and dry land, 8 *bagayat* and wet, and another 8 wet and dry. The remaining own land of only one class ; thus 12 hold only *bagayat* land, 14 hold only wet land and 24 only dry land.

Taking the figures for the whole State, the following extract from the Season and Crop Reports of the year 1921-22 shows the present situation :—

Holdings	below 1 acre	93,412
„	between 1 and 5	481,238
„	between 5 and 10	262,877
„	between 10 and 50	196,475
„	between 50 and 100	19,546
„	between 100 and 500	2,780
„	above 500	96

In other words 9 per cent of holdings are of less than 1 acre which from the point of view of affording a living by itself is as good as nothing. About 46 per cent are between 1 and 5 acres and another 25 per cent between 5 and 10 acres, bringing up the total of holders owning less than 10 acres to fully 80 per cent. It is not known how these holdings are made up, that is, how much is made up of dry land, how much wet and how much garden land. But taking even a liberal view of this aspect of the matter, knowing as I do the precariousness of farming in our State, these figures to my mind reveal the exceedingly hard conditions under which the man who depends only on the land lives in our State. For a farmer with an average family to wrest a living from an average holding must be a perpetual struggle ; and when it is remembered that land is about the sole means of his livelihood one cannot wonder that the *raiyat* has to be satisfied with a very low standard of living indeed.

The term "holdings" in the above table is also somewhat misleading. It does not mean the self-contained farm which it usually implies, but only the total area of the particular holder concerned whether it is a real farm or merely an aggregate of fields lying scattered here and there. In the case of the larger class especially, they are merely landed property owned by these individuals who for the most part have nothing to do with the cultivation ; few of them are self-contained ; they are composed of scattered fields in different villages or in the different parts of the same village and parcelled out to a large number of small farmers. When comparisons are made with "holdings" in other countries this point will have to be borne in mind. We shall also have to confine these comparisons to countries which are largely composed of small farmers,

Taking Denmark first, a country with its cultivated area almost equal to that of Mysore, the holdings fall into the following groups :*

	No.	Average size.
Holdings from ¼ to 6 acres	92,656	1.6
„ 6 to 24½ „	66,291	12.6
„ over 24½ „	73,889	74.7

In other words 40 per cent of the holdings are less than 6 acres, about 29 per cent between 6 and 24½ and the remaining 32 per cent are above 24½ averaging as high as 75 acres each. These holdings are moreover real farms and not an aggregate of mere scattered fields. Both in size of the holdings and in their compactness this little kingdom is far in advance, not to speak of other points of superiority.

In Belgium, also another country of intensively cultivated "small" farms, the cultivated land falls under the following groups :—†

Below 1¼ acres	458,120
Between 1 and 24½ acres	326,819
Between 24½ and 125 acres	41,102
Above 125 acres	3,584

The farms below 1¼ acres here amount to over 50 per cent of the total and those above 1¼ but below 24½ acres amount to about 35 per cent ; this is pre-eminently a land of small holders and were it not that the units of classification are not identical with that adopted for Mysore it would have been possible to make a closer comparison.

In Japan, another land of small holders again, the cultivated area is classified as under :—‡

	per cent
Below 1¼ acres	49
Between 1¼ and 7½	42
Between 7½ and 24½	7.7
Above 24½	about 1

Fully 91 per cent of the total holdings are below 10 acres in extent, a figure which makes out condition very much worse in this respect than even in Mysore where the figure for holdings of less than 10 acres is only 80 per cent.

It must be remembered that in the absence of information regarding the earnings from land, other occupations open to the people

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* *Report of the Scottish Commission of Agriculture to Denmark.*

† *Bulletin of the Bureau of Economic Intelligence*, July—Sept. 1925.

‡ *Bulletin of the Bureau of Economic Intelligence*, Oct—Dec. 1923.

and so on, these figures do not throw much light as to the nature of an economic holding as far as size may be held to determine what it may be.

The question as to what really constitutes an economic holding is rather a difficult one to decide ; so much depends upon the class of the holder socially and his standard of living ; and in the case of one and the same holder it also varies according to the proportion of its component parts, namely, dry, wet and garden, and in each of these two in accordance with the soil, rainfall and other facilities for cultivation. On the whole with the class of raiyats to which the bulk of the people belong any holding fetching a labour income which will afford a margin, however small over and above the common village standard, namely, food and clothing and which will at the same time furnish work throughout the year for the farmer, his family and his working bullocks, may be taken as a very rough guide as nothing better is possible under the circumstances. As already stated, only a combination of the three classes of cultivation will afford such scope without resort to the necessity of any subsidiary occupations. Such a combination is also ideally adapted to the support of a maximum number of agriculturists. This ideal, however, is naturally impossible to attain everywhere, but to the extent that such combination is made possible by means of chiefly a development in well-irrigation, will the ideal of economic holdings be attained. Such a holding as will furnish labour for the farmer and his family throughout the year and will not necessitate their seeking labour outside is in fact the point on which the peasantry has everywhere insisted. It may be interesting to note that in Denmark when peasant holdings were constituted, the larger landholders were quite averse to concede this point for fear of losing their accustomed sources of labour, though the peasants eventually carried the day.

In our own State a minimum area for survey numbers beyond which it is expected a holding may not be sub-divided is usually fixed by the Government when the lands are surveyed at the periodical settlements as already explained. This, however, in actual practice is only a dead letter. There is nothing to prevent any one or other of the various causes tending to sub-division operating to defeat this wholesome rule. Holders of the minimum areas prescribed are at liberty to parcel them between tenants, to alienate by sale any

portion of the entire number or to have it divided at the time of the family partition. As a matter of fact the areas fixed at the first survey are very much larger than the present limits. The first survey had in view the excellent criterion that the holding should be such as could be farmed with the aid of one pair of bullocks. They accordingly fixed,

20 acres for light and red soils (dry land)*
15 ,, medium ,, ..
12 ,, ,, ,, ..
4 ,, paddy land

The present limit, *viz.*, 4 to 6 acres for dry land red soils, 10 acres for black cotton soils and 1 acre for paddy lands forms an excellent index to gauge the forces acting to bring about sub-division of holdings.

V. Causes of the Sub-Division of Holdings and of the Small Areas Farmed.

Into the causes which bring about such sub-division we may now go in some detail. The foremost cause lies certainly in the law of succession to property by which the father's property is partitioned equally between his sons. Except in the case of certain special tenures which are practically negligible there are no estates governed by the law of primogeniture. There is no law either which prevents the partition of holdings once they are formed by insisting that it shall not pass into the hands of more than one occupier which in certain countries is effected by compensating the other heirs by money grants or otherwise. The present law of inheritance, therefore, is the most important cause which has brought about the present fragmentation and which will in future bring about fragmentation when new consolidated holdings are created. The requirements of cultivation set some limits to fragmentation by even this powerful cause and prevents land being parcelled into very small strips. By mutual agreement called "Parivarthana" also division is so made as to keep fragmentation within limits; neither however affords any material remedy.

The second cause is the need for small units of land for purposes of purchase and sale. Land being almost the sole property on the

* *Mysore Revenue Manual*, Vol. I, p. 452.

security or by the sale of which money can be raised it forms the most frequent and natural object for transactions. Land further is clung to so tenaciously that it is seldom parted with except under great necessity and even then in as small portions as may be necessary. Small fields, therefore, form convenient denominations for the purpose either of complete alienation by sale or partially by mortgage.

The above two causes bring about fragmentation with divided ownership. But we have been dealing with the sub-division of holdings not only where they are divided between several owners but also with the division into several tenants although the ownership may continue single. This is really a most important aspect of the subject inasmuch as the ultimate object of consolidation is to put into the hands of the actual cultivator, be he a tenant or an owner, a self-contained farm unit such as we have defined. Any scheme of consolidation will fail to attain the object we have in view if sufficient safeguards are not taken to prevent the above. But it will be realized that the existence of such small tenants is due to the fact of the low profits of farming with which the average farmer is satisfied or rather has to be satisfied. As long as the standard of living continues to be what it is and as long as there is no diversity of lucrative occupations to relieve the pressure on the land which now remains the sole means of subsistence for 90 per cent of the people, this cause will continue to operate and no legislative enactments can prevent it. Even now it is not as if there are no large self-contained holdings at all. There are quite a large number of persons who own land all situated in a compact block and capable of being farmed as a good consolidated holding. But these are all divided up and let to tenants, the owner himself having little or nothing to do with farming except the rent receiving part of it. Take again the large number of *jodi* villages which approximate closely to the type of self-contained holdings we are considering. As a general rule, these villages possess both wet and dry lands and sometimes garden lands also all under a single ownership of either an individual or a family. The whole of the wet lands and a portion of the dry land constitute the home farm of the *jodidar* while the dry lands are permanently leased to tenants. The whole of the wet area and the tank being the property of the *jodidar* the regulation of the water, the nature of the cultivation, the crops to be grown, etc., are entirely in the hands of the

jodidar. The large number of the dry land tenants also furnishes on the spot all the labour that may be required. Judging from these conditions, one would expect that these are the very areas where large-scale improved and highly profitable cultivation would be carried on in the way expected of a compact large holding. And yet with very few exceptions these lands are also farmed just like any of the other villages and their peculiar advantages not at all availed of. A sub-division of holdings appear to be in fact inevitable and unavoidable under the present circumstances. The *raiyat* is content to live on the barest minimum and pay to the owner what the owner himself would make as net profit if he farmed it himself, with the result that the owner prefers to let the land and himself earn anything he can as a trader, Government servant, and even as a menial servant.

VI. Examples of Consolidation in Other Countries.

We may now turn to a brief survey of the consolidation movement in some of the principal countries of the world. for it is something after the same pattern that has to be attempted here also. should a proper case be made out. The earliest and certainly the most interesting examples of consolidation are furnished by the enclosure movement in rural England. Prior to this movement. cultivation in England was all on the open field system. The entire arable land was divided into two or three strips in a two or three years rotation scheme and farmers owned strips of land in each of the three sections, the fields of holders not necessarily in compact blocks but scattered. Fields were left unenclosed naturally and after the year's harvest was over the whole area was left open for all the village cattle to roam over and graze the stubble. Adjoining the arable land of the village was the extensive grazing area or the village common or what we should call the village *gomal* on which the whole village had common grazing rights, proportioned, however, to the extent of arable land farmed by each holder. Independent farming was impossible and conditions in this respect may be said to have been much as they are to-day in our midst. A disposition on the part of the lord of the manor or other landholders to consolidate and enclose their holdings including portions of the common and to continue to enlarge them was assisted by special legislation. The essence of such legislation both here and in other countries where the same has been enacted and to which we shall refer presently is the consent of the majority

of the landholders to a system of rearrangement given willingly or wrung somehow. Very elaborate and costly proceedings had to be taken in each case where a parish proposed to rearrange its land. None of these, however, was effected without causing a great deal of hardship to the smaller landholders, nor without loud and bitter complaint on their part that the larger landholders were swallowing up the smaller. It was, however, a time when great profits were being made in the wool trade and the keeping of sheep became a most popular industry. Large farms properly enclosed for the keeping of sheep were greatly in demand and acted as a powerful stimulus to the movement. Nevertheless it was not until British agriculture was quickened by ideas brought from the continent and by the teaching of agricultural reformers like Jethro Tull and the introduction of root crops meant as winter feed for cattle, that is to say, not until new types of farming became possible that the movement began to make any rapid progress. The stimulus of sheep keeping profits and this transformation in the type of farming are factors to be well borne in mind in this connection, because without this powerful aid, the movement would probably have stagnated notwithstanding all the legal support that might have been afforded. With the growth of prosperity, the movement expanded rapidly and what originally were mere enclosed large estates became regular self-contained farms with the farmer's homestead, labourers' cottages and so on such as are seen to-day. The old parish consisted no longer of an aggregate of farmers' dwellings but became reduced into merely the centre of common amenities containing the village tradesman, artisans, the landless or poor cottagers, the village inn and so on. In this English movement, the consolidation has progressed in a more or less haphazard fashion there being no limit to the extent to which fields can be thrown together and made into single farms. The idea of farms as such, that is, self-contained holdings enclosed, suitable for independent farming and with the farmer and his labourers living on the farm became however well-established ; and in all the successive changes in land policy in England where it has swung to and fro between large farms and small farms this central idea of the self-contained farm has remained unchanged.

The consolidation of holdings above described was not effected, we may add, in any hurry. Having begun in the early part of the

15th century it has gone on through the succeeding four centuries and more and even in the beginning of the 19th century could not be called complete. The industrial expansion of England and her ever-widening colonial Empire have been valuable aids to the movement inasmuch as they have enabled her to find an outlet for the surplus rural population squeezed out of the land by the movement and thereby to prevent any violent agrarian convulsion. A most interesting account of the whole movement can be gathered from Prothero's *History of English Farming, Past and Present*, from which the above has been extracted.

The consolidation movement in Denmark* furnishes a more modern European example of another character. Here both crown land, common land and land acquired from large farmers were constituted into conveniently sized peasant holdings to be worked as self-contained farms. All expenses connected therewith were charged to the selling price of the farms and peasants were encouraged by means of special state loans or loans through private banks to acquire these farms, to erect buildings and to stock and equip the farms suitably. The farms were also to be under one ownership and in no case to be split up. Farms could be added to and enlarged by the absorption of adjoining smaller farms but in no case could they exceed the limit fixed, namely 10 acres of average land or 16 of poor land. There is a corresponding minimum area also, namely, $2\frac{2}{3}$ acres beyond which no farm could be whittled down. The central idea underlying consolidation in this country is also the creation of self-contained farms through the agency of the State, the cost being borne by the people themselves.

Rearrangement or restripping in a stricter sense and more applicable to conditions in this country has been carried out in many European States, *viz.*, Austria, Switzerland, Prussia, and among Asiatic countries in Japan. It is needless to go into the actual measures adopted as a general idea of the aims would have been gathered from the discussion so far. The common features only may, therefore, be summarized.† These are : (1) Legislative sanction for the State to under-

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* *Report of the Scottish Commission of Agriculture to Denmark* : *Rural Denmark*, by Rider Haggard.

† *Vide* especially *Bulletin of the Bureau of Economic Intelligence*, April 1912, for fuller information.

take and carry out the scheme, (2) the voluntary agreement of a majority of the holders concerned for such a rearrangement, the majority fixed generally being $\frac{2}{3}$ the number of holders whose holdings in the aggregate amount to not less than $\frac{1}{2}$ of the total area, (3) legislation enabling the will of this majority to prevail over and compel the remainder to submit to the rearrangement, (4) the whole village land then considered as new land, old boundaries all removed, roads and paths marked out and the land parcelled into holdings of rectangular blocks of suitable size and allotted to the holders either in proportion to their original holdings or sold by auction among the villagers, credit being given to them for the value of their original holding, (5) the new holdings to carry such encumbrances, rights and obligations as did the old. In certain States (Austria), facilities are given, in the nature of a kind of half-way house, for the exchange of plots between various holders to effect consolidation of scattered fields. In Japan too, no such pooling and creation of holdings absolutely *de novo* seems to have been attempted, but only such action as may be necessary for the formation of roads, channels and ditches, straightening of field boundaries and the reclamation of poor land.

There has evidently been no necessity to guard by legislative provision against sub-division, as all these countries are increasing in prosperity and the tendency appears to be on the other hand for small farms being merged into larger ones by the acquisition of more and more land by town dwelling men who make large profits in trade, industries or other walks of life. Between the year 1918 and 1921, we are told, for instance, in Japan that the number of such large landowners rose from 3,223 to 4,277 or by 30 per cent which no doubt means the extinction of many times that number of small owners. The time may come perhaps when the pendulum may swing back and the need be felt for smaller holdings. This, however, does not concern us here.

Another instance of consolidation belonging to a somewhat different category may now be referred to. This is the recent consolidation of holdings carried out in certain villages in the Punjab through the agency of co-operative societies. It is perhaps unique and must be considered a remarkable achievement due doubtless in no small measure to the personal enthusiasm and efforts of the indefatigable Registrar, Mr. H. Calvert, I.C.S. Special Societies for this purpose

were formed and at the instance of the majority amongst them, a rearrangement of the holdings to which the others had to submit was settled upon and recognized in the Government registers later when every holder concerned gave his assent to the exchange. It has been attempted with very conspicuous success and a large number of compact holdings have been carved out of a multitude of scattered fields. Here also no attempt has been made to prevent by means of special provisions the splitting of these compact holdings by causes familiar to all of us. It is evidently felt that the advantages will be so fully appreciated and the difficulties surmounted in bringing those holdings into being so keenly remembered that owners themselves will adopt such measures as will avoid a reversion to the old state. In any case the matter does not seem to have troubled the promoters. The peculiarity of the Punjab method lies in the extent to which State intervention and State initiative have been dispensed with and the matter looked upon as more a people's concern and worked out accordingly.*

Before bringing to a close these examples of consolidation reference may be made to the formation of holdings in newly settled tracts or colonies. In the United States of America land is surveyed and set out into square blocks of a section each measuring one square mile and each of such sections divided into four equal quarter sections by means of wide farm roads. Each quarter section forms a minimum holding self-contained and excellently served by roads. Farms may consist of one or more such quarter sections and do often run to mammoth sizes. The Punjab canal colonies settled in the newly irrigated tracts of that province have also been excellently set out, so that holdings may be self-contained, fenced, well served by roads and so on.

Reference has been made to these because large blocks of land in our State also are periodically thrown open for cultivation. A large area of Amrit Mahal Kaval lands have recently been surrendered and is being given over for cultivation ; so are areas of land set free from the forest zone and very large blocks of Government waste land likewise becoming available for cultivation. Expansion of canal irrigation has been very great during the last 15 years and a huge further increase is in prospect. In these, at least we have practically a clean slate to write on where the above examples may well be copied.

* For details see Vol. IV, No. 1 of this Journal.

Reference may also be made to the scheme of large landed estates started some years ago with the laudable object of creating self-contained holdings suited for being worked by moneyed farmers. Little or nothing of advantage has accrued however as a result and the matter has evidently gone into the limbo of forgotten things.

VII. Line of Action Proposed for Mysore.

In discussing then the line of action to be taken in Mysore, as far as the desirability of consolidation is concerned enough has been said to show that it will be a great advantage and that the present conditions hamper progress materially. The question is one of ways and means of the actual method to be adopted. The examples described above no doubt indicate the ways adopted in foreign countries and in the Punjab and action will certainly have to lie along either direct State action or through the agency of co-operative societies or the villagers themselves. To most of us indeed the difficulties incidental to any scheme assume a somewhat threatening magnitude. How will our villagers among whom cohesion has all but disappeared with their mutual jealousies and quarrels and the petty village factions acquiesce in a change of such a fundamental character ? and when it is considered that the scheme contains within itself the causes of its own unmaking, with the present law of inheritance and the need for small units for sale or mortgage, why erect it at all ? Neither a change in the law of inheritance nor the prevention of transfer of land in sections can ever be thought of as practicable propositions. This to most is really the stumbling block which stands in the way of our ever making a beginning. The Government of Madras in their orders on this subject put this aspect of the matter bluntly and frankly thus :—

"The Government consider that so far as this Presidency is concerned the problem is beset with difficulties and that it is not capable of such an easy solution as might appear at first sight. The proposal seems to be contrary to the tradition and practices of the smaller holders of land. There are again cases in which sub-division is inevitable, *e.g.*, where part of a holding is divided among the joint pattadars. Refusal to sub-divide will result in hampering dealings in land and merely increase confusion between real and nominal owners.

Legislation in such matters is out of the question ; and any attempt to discourage sub-division below a certain unit by the levy of a prohibitive fee or otherwise is likely to be resented. The Government consider that so long as sub-divisions have to go on for one reason or another any attempt at consolidation of existing fragmental holdingr is bound to fail and that it will serve no useful purpose to allow ths time of settlement officers to be wasted over it."

This of course is an argument for dropping the matter altogether and does in no way help us to find a way out of the difficulty and secure to the country such advantages as are expected to accrue from a consolidation of holdings. It, however, sums up the attitude of a large majority of people and helps us at least to gauge the measure of opposition which is likely to be met with.

The causes tending to sub-division mentioned above are certainly very powerful ones ; but it must be remembered that they will always be there. If they are considered serious enough to prevent action being started now, action will have to be put off indefinitely for we can never think of a time when they will cease to operate. I think it is some such consideration which has been instrumental in the starting of the scheme in other countries where too such conditions exist. It is one of those cases where once the advantages are demonstrated, means would be found by the people themselves to retain them in spite of the difficulties we have been considering. In the gradual change and improvement in the economic conditions, the expansion of trade and industry, the increase in the demand for labour in the towns and industrial centres and also in the general level of education, we should also expect auxiliary causes which will favour the permanence of the consolidated holdings when once made. In any case unless the profits of farming can be materially increased by not only an increase in the profit per acre by better methods of cultivation but also by an increase in the minimum area farmed by any one holder, land will cease to be a popular calling, compared with the growing number of other occupations which afford a better labour income to the workman with the additional attractions of city life. Whether any legislative assistance should be sought for on the lines of other countries is a question. In my opinion, at this stage no such step should be thought of. Any compulsory legislative act by Government even when a fair number of holders should be willing to have their

holdings consolidated will defeat the very object ; it will arouse great opposition and will throw even those who may be capable of conversion into the hostile camp. After all even the most enthusiastic among us should admit that beyond a little agitation at the top so to speak practically nothing has been done to interest or educate the villager—the man actually concerned in the matter—and to enlist his support. It is absolutely no use to say that he is too ignorant, too parochial and narrow in his views and so on, and that we shall in true parental fashion take him in hand and force him into new paths. We have to do a great deal of propagandist work, accustom the villagers to the idea, examine their attitude, argue and convince them, in fact create an atmosphere favourable and so necessary for any general action on these lines. The *raiyat* is not after all so unmindful of his interests, so blind to the chances of advancement and gain as to be impossible to change ; my experience has been quite the contrary. It is difficult to agree, therefore, with the argument of Prof. Jevons that "the expectation of a profit three times greater than that which may be fairly anticipated would not be a sufficiently powerful economic force to bring about the change" on which he supports the case for the necessity of Government intervention and special legislation. A great deal of propaganda work explaining the advantages of consolidation will have to be conducted, preferably in a few selected villages in the beginning. As many as may be willing to have a rearrangement of the holdings, to agree to an exchange of fields where necessary for this purpose should be enlisted and as soon as about 250 acres in any one village or group of two or three contiguous villages are likely to come into the scheme, then the assistance of a special officer should be available to survey the lands properly and to effect a rearrangement giving to each of these men the extent of land they may own, in one block. The rearrangement should also, as far as possible, be so made that all the holdings abut on a road, so that each holder may have independent egress or ingress to his own farm. The new holdings should be recognized as new survey numbers, the entire holdings being taken and not fields thereof ; the new boundaries should be recognized in the Government records ; no increase in the assessment on the increase in area due to consolidation should be made. A number of concessions will also have to be shown. A small area should be set apart in the newly constituted holding itself for the homestead and this and an

area of about ¼ acre adjoining it should be made revenue free. Dwelling in the farm itself should far from being penalized as at present be made as easy as possible and be encouraged. If irrigation wells should be sunk and well cultivation started on this holding, a guarantee should be given that no enhancement of assessment will be made at the resettlement on the area brought under well irrigation ; no fee of any kind should be leviable for the transfer of the fields involved from one owner to another. After the owner moves out into his new home on the farm he may be exempted from house-tax leviable in the village if he chooses to give up his house site or house in the village. Probably other inducements depending upon local circumstances will have to be held out also, so that the scheme may be made sufficiently attractive for them to consent to make the beginning. Once the beginning is made it is almost certain that the advantage will eventually be so well recognized that they would not like to change. Should at any time the village *gomal* be decided to be given over for cultivation it should be divided into large blocks divided by or abutting in a common road and given on condition that each block is farmed as one unit, with the *raiyat* living on it. It will be advisable also that in the first attempts a committee composed of the higher officers of the Revenue, Survey, and Agricultural Departments is entrused with this work who may meet as often as may be necessary to carry through the work after the necessary consent has been obtained from the raiyats willing to effect the transfer. This arrangement will lead to promptness, as not only the ability and experience of the officers but also their official position will make them competent to give quick decisions on the different matters that may arise. As regards the kinds of villages to be taken up, it will be well to take up some good dry land villages or group of villages preferably in the headquarter district of Bangalore. In addition to these, from the channel area a fairly small village in which lands are owned by the villagers themselves and not by absentee landlords should be taken up to effect the rearrangement of the type necessary to suit the special conditions of this area. It is very likely when the scheme works in a village or two or even in parts thereof, more villages would like to come into it voluntarily. Without being unduly optimistic it may be safely reckoned that landholders are not so blind to this advantage as not to understand and profit by it when they see it demonstrated.

This method suggested above follows the plan adopted in the Punjab through the co-operative societies referred to. It proceeds in easy steps and has naturally the disadvantage that what is accomplished may not be thorough or perfect. Only portions of villages may be involved, the holdings may not in all cases have straight and regular boundaries and the providing of roads, etc., may not be always easy. But it has the merit of quicker accomplishment, because it would be far easier to bring a few people to agree than a whole village.

Whenever large blocks of land are being newly thrown open for cultivation and wherever new areas are brought under irrigation under any new schemes, such land should, before it becomes too late, be divided up so as to afford the facilities of a perfect method of consolidation. Blocks should be made large and rectangular, roads and paths should be provided to serve every holding, provision should be made for independent irrigation channels and drainage ditches in the case of irrigated areas, in fact the division made somewhat on the lines of the new Punjab canal colonies. In dry land areas, it should also be insisted that *raiyats* should build houses and live on their land. The sole care of the Government should not be considered to lie in seeing that the land is taken up by somebody and the land tax thereon is regularly paid, but the conditions of grant should also be enforced, though such enforcement may result in the relinquishment of the land and the loss of the land revenue thereon. That the land should be under some good form of cultivation if not under the best form of it, should be a weightier consideration than the payment of the tax alone.

It is just possible that in certain *jodi* villages the relation between the *jodidar* and tenants may be such that he may be able to effect considerable rearrangement of the land without great difficulty. For one thing not being the property of Government, no question of general applicability involving changes in existing rules will arise and the *jodidar* being a free agent may, if he is only keen on the matter and goes about in a generous mood, be able to make such changes without serious difficulty. Any technical help required by way of surveys, grant of Government land free for roads and any other small concessions that may be needed, should be granted.

It will be seen that the scheme being quite novel will have to be tried as an experimental measure in a few selected villages. Unless a beginning is made the actual working difficulties will not all be clear; possibly there may be even agreeable surprises; some of the difficulties we have feared may not occur at all, *raiyats* may consent in larger numbers, enough to form the co-operative society of the kind formed in the Punjab for the purpose.

At this stage the objection about the possibility of sub-division coming in later on due to the law of inheritance and so on will have to be ignored and no complication that consideration to that objection may necessitate, be introduced. One should also not trouble about any legal provision for the holder to register his new holding as of a special class which should be declared impartible; nor to provide again that it shall be transferable only in its entirety and that no mortgage or sale should deal with it piecemeal. In fact neither of these is possible and any attention bestowed on them as a condition precedent to the scheme and as indispensable to its permanence when once it is started going, would merely paralyse action without any chance of our doing anything by way of amelioration. We should in fact steer clear of the need for any legislation. We should make the scheme simple, move along the lines of least resistance, make the scheme attractive, only seeking and obtaining all the help Government can render as purely executive measure; and in regard to ensuring permanence of the holdings when once formed we shall have to trust to the intelligence and good sense of the holders themselves to realize the advantages too well to allow any disintegration.

Although the fragmentation that exists is undoubtedly an evil, yet if we exclude the cases where it is due to the exigencies of the cultivation itself, and the cases where it can be remedied partially at least by ordinary executive action on the part of Government, the bulk of what will be left to be dealt with by drastic measures has not assumed such serious proportion as to call for legislative action which is bound to be unpopular, to say the least of it. If we assess moreover the importance of the consolidation of holdings among the various factors tending to increase the profits of farming, such as the improvement of the irrigation sources, the provision of artificial manures, the improvement of crops and live-stock, the checking of

pests and diseases and so on, in the present condition in the State it comes a long way behind. Drastic measures for bringing about consolidation are certain to draw away attention from and to jeopardize the chances of success along the more important lines of agricultural improvement. It is in view of these considerations that action is recommended along the lines of propaganda, persuasion and practical demonstration on a small scale, exactly similar to the lines on which other agricultural improvements are sought to be popularized.

NOTES AND COMMENTS.

Consolidation of Holdings.

The article by Mr. A. K. Yegnanarayana Iyer published in this Journal deals with the subject in a very extensive manner and makes certain practical proposals. We earnestly request the Members of our Union to take interest in the matter and bring about a certain amount of consolidation through co-operation and persuasion in their localities.

* * * *

Ontario Agricultural and Experimental Union.

The Secretary's report of the above Union published under "SELECTIONS" in this number of the Journal shows the variety of work undertaken by the members of the Union and the results achieved. It is needless to say that the work done is of a high standard. The items of work attempted and the results achieved give our members a good idea of how much remains to be done here on similar lines.

* * * *

Research Work on the Soil during the last 25 Years.

A summary by Dr. Russel of Rothamsted published under "SELECTIONS" in this number of the Journal clearly shows the progress made in Soil Science in various important directions. The subject of soil acidity is receiving attention in this country as well. Coffee soils and soils from the Malnad are being studied with regard to the degree of acidity and their lime requirements. A good number of samples have been tested and show varying degrees of acidity. Liming experiments on the Marthur Farm have shown that sugarcane grown there clearly responds to lime treatment bringing in considerable increase in yields. If the majority of soils in the Malnad show similar reaction, then an active campaign for the application of lime to the soils will have to be carried out.

Work on coffee soils has just been started and a few of them show a distinct acid reaction. A large number of planters are already in the habit of applying lime to their soils periodically, but the results do not seem to be satisfactory on all estates. Systematic work on

the testing of these soils before liming will be undertaken in the near future to give the planters as much help as possible in this direction.

* * * *

Ford Tractor *Vs.* Ploughing by Means of Horses.

Experiments conducted in Germany showed that a tractor of 25 H-P could plough about 4 acres of light land to a depth of 20 cm. at a resistance of 40 kg. per sq. cm. For this work the tractor used up 36 kg. of petroleum costing 10 mks. 80 pfg. Adding to this the cost of oil also, the running charges per day worked out to 13.50 mks. or 3.5 mks. per acre.

The same amount of work was turned out by using a plough with two shares and drawn by a team of 6 medium-sized horses or 4 heavy animals, and the cost of feed for the animals came up to 3 mks.

It was determined that the 25 H.P. tractor turned out no more work at the plough than a team of 4 or 6 horses and that 60% of its power was required for its own ration and hence only 40% was available to work the plough. It is too small for big farms and not suited for small ones. Moreover, it is not capable of being adjusted and applied to various kinds of work on a farm.—Bieldermann's Centralblatt, Vol. 54, August 1925, Page 384. [B.N.I.]

SELECTIONS.

I

The Extraction of Oil of Lemon.

Oil of lemon is a volatile oil contained in distinct cells in the exterior rind of the lemon, which may be separated by simple expression.

The rind is first grated from the fruit and then subjected to pressure in a bag of fine cloth. The oil thus obtained is allowed to stand till quite clear and is then decanted and kept in stoppered bottles.

The oil may also be obtained from the grated pulp by distillation, but it is stated that the product obtained in this way, though less liable to change when kept, has less of the peculiar flavour of the fruit, and for this reason expression is generally preferred.

A third method, used in Calabria and Sicily, is to put the grated rind into hot water and skim off the oil as it rises.

The finest oil is obtained by the use of an instrument made of tinned copper, bowl shaped, and armed with concentric rows of short spikes. Attached to the bottom of the bowl is a hollow handle closed at the bottom, which serves as a receiver for the oil as the fruit is rubbed by the workman over the sharp teeth.—A. A. Ramsay, *Chemist*, in *The Agricultural Gazette of New South Wales*, Vol. XXXVI, Part 10.

II

Arsenic Pentoxide as a Poison for Prickly Pear.

Arsenic pentoxide is distributed in a powder form by the Prickly Pear Land Commission of Queensland and has been found to be most efficacious and the cheapest form of poison for the destruction of prickly pear. The Department has not carried out any tests with arsenic pentoxide in the powder form, but tests which have been made by the Queensland Prickly Pear Commission indicate that it is cheaper and more convenient than any other form provided it can be applied by an injection. It has the advantages that when once introduced into the pear plant it circulates both to the extreme segments and to the extremities of the roots, and then completely destroys the plant. Unlike arsenic, it is soluble in water. It is not dangerous to handle, is economical in use, and may be supplied to landholders in a concentrated powder form.

Experiments have shown that the poison is so powerful that one-twelfth of an ounce will destroy pear plants weighing 1 cwt. The poison does not entail danger to stock. The powder, before being used, is mixed in three to four times its weight of water. The present price is about 6*d.* per pound.—A. H. E. McDonald, *Superintendent of Agriculture*, in *The Agricultural Gazette of New South Wales*, Vol. XXXVII, Part 3.

III

The Village School : A Powerful Potential Factor in Rural Improvement.

The improvement of the village school as an educational and social centre needs the most urgent consideration. Most of the pupils that fail to complete the primary grades are children in the rural districts, the future producers of agricultural products of the country. There are several reasons for their few years in school. Rural people are too poor to let their children continue schooling in towns where the higher grades are taught. They need their children to help them in their farm work. Also many rural children are so poorly prepared in their school work that they cannot coach up with the town children. Generally they quit school before completing the primary grades. Most of the graduates in the elementary schools are city children. Among the high school graduates there are very few who come from the rural districts. This is one reason why our high school graduates do not go to the farm. They do not come from the farm.

The farmers do not come from children raised and trained in cities. With the exception of a few who were trained in the farm and agricultural schools the farming population comes from the children in the rural districts. City families rear city people and rural families, rural people. Therefore, if we want to raise the proportion and standard of our rural population, we must keep in mind that the village schools in the rural districts are the places where the people get their initial training.—*The Philippine Agriculturist*, Vol. XIV, No. 10, March 1926.

IV

The Use of Pen Manure for Sugarcane.

The following summary of a Report on the Results of Experiments in Sugarcane Cultivation in St. Croix during the seven-year period from 1915 to 1922, is extracted from *The Louisiana Planter and Sugar Manufacturer*, Vol. LXIX, No. 25, page 419, December 1925 :—

In these experiments the general results obtained in previous trials have been confirmed. All our work points to the fact that pen manure

produced in St. Croix when applied to cane land has little or no effect in increasing the yield of plant cane. Unfortunately this report is being prepared soon after the removal of the plant cane crop, consequently there are no results available from the ratoons. In view of the very general trend of results from previous tests we feel justified in submitting the following conclusions :—

1. There is little or no increase in the yield of plant cane following the application of pen manure.

2. There is usually a small increase in the yield of ratoon following the application of manure on land well tilled and free from weeds.

3. Any increase that might be obtained following the application of stable manure is so small that it would not justify the purchase of this material and the use of it should be limited to the use of such as is produced on the estate itself.

4. Only well decayed manure should be used as the so-called "long manure" which in reality is nothing more than trash consisting of dry unrotted vegetable matter is more detrimental than otherwise.

In view of the results of experiments to the contrary conducted in widely diverse sections of the globe, it must appear strange indeed that the application of manure in St. Croix has not increased soil productivity when sugarcane is the crop concerned. A little inquiry into local conditions under which manure is produced may help to explain away some of this mystery. In the first place, pen manure is produced in open pens with pervious bottoms. These pens are constantly subject to the action of the elements and the hot tropical sun and warm tropical showers act upon the manure alternately. Trash from the fields is frequently hauled into the pens to insure a dry surface for the animals and to add to the quantity of manure. Most of the work stock consist of bulls or oxen and they are never fed a ration containing grain. During the harvest season cane leaves are fed and between seasons green grass and trash are substituted. There are frequent periods of drought when green grass is not available and trash alone is fed. Furthermore the bulls are in pen during the night only and the small quantity of droppings produced are mixed with a relatively larger amount of trash. So it is made plain that under the conditions of the production what may be called "first class manure" in St. Croix is in reality only well rotted weeds and grass. The beneficial results from the application of such manure arise more largely from the improved physical texture it imparts to extremely light or extremely heavy soils than to the addition of any considerable quantity of the common elements of plant food.

V

Advantages of Co-operative Experimental Work in Field Husbandry.

1. It systematizes seed distribution along definite lines and for valuable purposes.

2. It distributes the very best seeds, plants, fertilizers, etc., among the best men and then assists and encourages those same men to experiment and to investigate.

3. It furnishes hundreds and even thousands of object lessons annually which form centres for interesting study along the lines of progressive agriculture.

4. It helps the farmers to help themselves.

5. It educates along the lines of careful handling, close observation, accurate calculation and economical methods.

6. It trains men to unite science with practice and to lead other men to do likewise.

7. It helps the farmers to understand better the scientific principles that they read about in bulletins, reports and newspaper articles and that they hear about at agricultural meetings.

8. It supplies a direct as well as an indirect source of information for the farmers.

9. It enables practical men to obtain information regarding varieties of field and garden crops, selections of seed, dates of seeding, methods of cultivation, ways of increasing soil fertility, etc., for their own particular farms which they could not get in any other way.

10. It enables farmers to get a supply of pure seed of the leading varieties of grains and potatoes, which rapidly increase in quantity, and thus furnishes seed for sowing and planting on large areas and for selling at good prices.

11. It provides a wholesome and an attractive bill of fare for the farmer's table by encouraging the cultivation and use of sweet corn, high quality beans, etc.

12. It leads to a substantial increase in farm profits.

13. It works successfully in nearly every branch of farming.

14. It penetrates into those parts of the country where agricultural advancement is ordinarily very slow.

15. It supplies valuable topics and results for discussion in the field, at the fireside, in the corner grocery, and at meetings of farmers' clubs.

16. It stimulates the local newspapers to take a deeper interest in advocating better methods of farming.

17. It furnishes some exceedingly important results for printing and distributing in the form of bulletins and reports.

18. It adds dignity to farming and pleasure to farm life.

19. It exerts a wholesome influence in keeping the farm boys interested in farm work.

20. It trains the best men of the country, including the college graduates, to help in the solution of scientific problems which arise in connection with the various departments of agriculture.

21. It furnishes a post-graduate course for young men after returning home from college.

22. It forms a bond of union between the college graduates and their alma mater, as well as among the graduates themselves.

23. It gives the graduates of an agricultural college an excellent opportunity for exerting a good influence in their respective neighbourhoods.

24. It establishes a sympathetic spirit between the workers at the experiment station and the workers throughout the country.

25. It enables both the station and the college officers to know better the real needs of the agriculture of the present day.

26. It makes a practical application of many of the results of the experiment station.

27. It helps to check some of the experiments at the central station by having similar experiments duplicated on hundreds of farms under different conditions of soil and climate.

28. It increases the popularity of the agricultural college, and helps to attract young men to the institution as students.

29. It develops a keen interest in the work of the experiment station.

30. It leads to a steady advance in agricultural education throughout Ontario.—*Forty-Seventh Annual Report of the Ontario Agricultural and Experimental Union*, 1925.

VI

Ontario Agricultural and Experimental Union.

Secretary's Report.

In 1925, there were ten Experimental Union Committees in connection with co-operative experiments throughout Ontario. This is the largest number there has ever been in any one year. The most of these have carried on co-operative work within the year and several will report at this annual meeting. The departments covered by these committees

are: Field Husbandry, Agricultural Botany, Forestry, Agricultural Chemistry, Agriculture, Farm Literature, Agricultural Physics, Bacteriology, Animal Husbandry and Horticulture.

Each committee consists of a director and two to four additional members. The separate committees are responsible for planning, developing and carrying out the work in their own particular departments. Any money grants to the various committees on experiments are expended for work of a purely co-operative experimental character.

It should be clearly understood that this whole movement is entirely voluntary on the part of all concerned. We believe that this largely accounts for the enthusiasm in the work, the economy in the operations and the far-reaching influences of the results. The co-operative experimenters throughout this Province not only enrich their own lives, but they also become public benefactors for the whole country.

For a quarter of a century the Committee on Forestry has given much encouragement to the reforestation of private holdings and in dealing with the problem of reforesting the large waste land areas situated in the agricultural portions of older Ontario.

Probably at no place in America has more definite work been done in testing out in a co-operative way recommended methods of weed eradication as the one developed by the Experimental Union. The more general use of these methods is now to receive careful consideration.

The study and use of cold storage plants and farm conveniences throughout the country has been continued during the year.

Triangle experiments with fertilizers on potatoes, sugar beets, and certain vegetables have now been in progress in different localities for three years under the Department of Agricultural Chemistry.

The Committee on co-operative experiments in Field Husbandry has completed the fortieth year's work and has had under its direct charge 43 distinct projects with farm crops. There has been a total of 107,633 co-operative tests conducted throughout Ontario, or an average of 2,691 per annum for the forty-year period. Naturally the work dropped considerably during the war and immediately after. In no year, however, were there less than 1,600 co-operative experimenters. It is interesting to note that in 1925 there were 2,832 farmer-experimenters, which is 638 more than in 1924, 1,126 more than in 1923, and 1,216 more than four years ago.

In 1925 application was made that five varieties of farm crops be placed on the eligible list for registration in Canada. These had been originated at Guelph and had made high records in both the College and the Union experiments. Of this number O.A.C. No. 144 Oats, O.A.C.

No. 211 Soy Beans, and O.A.C. No. 2 Yellow Leviathan Mangels have been accepted already, and O.A.C. No. 181 Field Peas and O.A.C. No. 85 Spring Wheat will likely be accepted in the near future.

Decreasing acre-yields of farm crops frequently occur in a comparatively new country. In spite of this, however, the principal farm crops of Ontario have given even higher acre-yields in the last two decades than they did in the twenty years previous. These increases are known to be due largely to the new and better varieties introduced through the College and the Experimental Union. The market value of the increases in acre-yields of three crops alone would amount to many times the entire cost of both the College and the Union for the past half century.

In 1925, as in other years, the work of the Experimental Union, in addition to its financial advantages, has been decidedly educative in its character and has exerted a wholesome influence throughout the whole country.—*Forty-Seventh Annual Report of the Agricultural and Experimental Union*, 1925, *Ontario Department of Agriculture.*

VII

Nutrition among Students in the Agricultural College.

The College of Agriculture, the Philippines, conducted an investigation into the nutrition of students of the College. The following extracts are made from the Report of a part of the investigation published in Vol. XIV, No. 10 of *The Philippine Agriculturist.*

"The promotion of the physical well-being of the student, as well as the direction of the purely intellectual development, is now a recognized function in progressive educational institutions. For years, the College of Agriculture has paid a physician to look after the health of its students; and the last two years a director has supervised their physical activities."

"The watchfulness of a physician and the wisdom of a physical director, however, are not enough to insure sound physical development, as the body as well as the intellect is affected by the environment. Hence, the location of an institution, the kinds of recreation, the housing facilities and the food eaten are vital factors in a student's welfare. Whether or not the site of the College of Agriculture was selected with wisdom from the standpoint of physical and mental development, it is not our intention to consider; nevertheless, we may venture the statement that there are indications that the College is fortunate in its location.

At present the housing facilities are inadequate, but good dormitories are being built as fast as money for this purpose becomes available. For several years a Mess Hall where wholesome food can be obtained at reasonable prices has been in operation."

From the data obtained the authors conclude :—

1. "The College of Agriculture students are better nourished than the boys in the Manila Colleges of the University of the Philippines, who were measured.

2. The Visayans and Olocanos in the College of Agriculture are better nourished than the average student in this institution.

3. The average status of nutrition for no group in the College of Agriculture was poorer than the average for this College."

The authors continue :—

"The fundamental causes of these differences in status of nutrition are difficult to explain. The following reasons are tentatively offered :—

1. The well-being of an individual does not only depend on the food eaten, but also on his surroundings. Manila is a city situated at sea-level on a delta, while the College of Agriculture is located on the foothills of Mount Maquiling. There is probably a difference in iavour of this College in the purity of the air. There are more evening amusement attractions in Manila that tempt students to keep late hours than there are in Los Banos. Also, these and other diversions cause the Manila student to waste time which he attempts to make up by studying very late at night, thus shortening sleeping hours. While on the College Campus, there are very few evening amusements, or day-time diversions to consume student's study time. Also, the lights in the College are not on later than 11-0 P.M. Consequently, College of Agriculture students are compelled to spend a reasonable amount of time in bed.

2. Owing to a wrong popular conception that the work i n the College of Agriculture is largely manual, the weaklings do not come.

3. Most of the Visayans in the College of Agriculture are athletes.

4. The Olocanos eat more vegetables than the other groups.

5. The Tagalogs and Pampangos live near Laguna Province, so even those who are not very able-bodied, come to the College. While of those of other groups whose homes are farther away only the able-bodied come.

It will be interesting to find out whether a student develops physically during his stay in the College. Further investigation may throw light on this question.

This investigation has already affected the dietary habit of some of the students. One with a low *pelidisi** and who ate very little vegetables is now eating more and more of this essential food material."

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* A word coined to denote the formula. The Pelidisi is an index of the nutritional state of an individual

VIII

Notes on the Cultivation of Annatto.

Annatto, Bixa orellana, is a large quick-growing shrub or small tree, native of tropical America.

The plant is cultivated on a small scale in India, Ceylon, the West Indies and other tropical countries for the dye afforded by its seeds. It also makes a good hedge, screen or windbreak.

Cultivation.—The tree is readily propagated from seed which is sown broadcast in slightly raised nursery beds about 5 feet wide. As soon as the seedlings appear they should be thinned out to about 6 inches apart. When the young plants are from 9 to 15 inches high they should be planted out in the field at distances of from 15 to 18 feet apart. The plant is very hardy indeed and requires no shade either in the nursery or when transplanted in the field.

The tree makes rapid growth in the open and under ordinary conditions will attain a height of 10 to 12 feet at the age of about two years, when it will begin producing fruit. It will continue to fruit for a number of years and the only attention it requires is systematic weeding and pruning of any dead branches.

There are apparently two varieties, one with a white flower with greenish capsules and the other with a pink flower and reddish capsules, the latter being the one usually cultivated. The flowers occur in terminal clusters while the fruits are ovoid, spiny, two-valved pods, containing from 30 to 50 seeds. The seeds are surrounded by a scarlet tissue from which the dye is obtained.

Yield.—The fruits are collected when nearly ripe and as the shells dry they burst open. The seeds are separated from the pods and after being thoroughly dried in the sun they are screened and shipped without removing the scarlet covering containing the dye. In this condition they are packed in double gunny bags and marketed as Annatto "seed.". Unfortunately the seed does not keep well and old stock is worth very little compared with fresh seed.

The yield is somewhat variable, but records from the Government Experimental Plantation, Serdang, show that the plant commences to fruit at about two years from the date of planting. The first year's crop gave an outturn of 5 cwts. of dry seed per acre and it is probable that this yield will be exceeded as the trees become older. Although the tree continues to produce fruit all the year round the heaviest crops are obtained in the months of March and September, following the dry periods. The market price fluctuates considerably and it has been known to vary

from 3*d*. per lb. up to as high as 1*s*. 6*d*. per lb., C. I. F. London. The present price is about 8*d*. per lb.

Uses.—Annatto dye is used to a small extent in colouring lacquer, silk, calico and wool, but its principal use is as a colouring matter for various foodstuffs more particularly butter and cheese and there is a regular demand for the product for this purpose. The active principle of annatto is annatoin.

Markets.—Hitherto there has only been a limited demand for this product and the consumption for the United Kingdom was within the region of 100 tons per annum, whilst a corresponding quantity was imported into the United States. The whole business is a comparatively small one and the chief supplies come from Jamaica and Southern India, where the crop apparently grows wild.

If the food preservative proposals issued by the Ministry of Health are put into operation the use of gamboge and a number of coal-tar dyes giving a yellow colour, will be prohibited. This might mean that annatto seed, which at the present time is only used in very small quantities, will probably find a greater outlet, as this is one of the very few yellow dyes upon which a veto has not been placed. This would of course have the effect of stimulating interest in the Annatto market.

In connection with a suggestion that annatto might be cultivated in Malaya as a commercial crop, enquiries have been made by the Imperial Institute, at the request of the Malay States Information Agency, regarding the present position of the market for annatto and the chief industries in which the product is now used.

As a result of these enquiries one firm of merchants stated that the demand for annatto appears to be increasing but in their opinion it is doubtful whether the total present consumption would warrant the seed being produced as a cultivated crop. They considered that the demand would require to be quadrupled before such a course would be worth while

If the producer were in a position to hold over his stock and to distribute it evenly over the year the business would be more profitable, but the lack of keeping quality of the product prevents this with the result that there is either too much on the market or none at all.

The wild crop from Southern India is rushed home as early as possible, usually about the end of February and early arrivals realize good prices. If a cultivated crop could be placed on the market earlier than the wild crop an increased price would be obtainable.

Further, a firm of manufacturers of cheese and butter colours, etc., who use annatto seed for the purpose, stated that the price of the best

annatto still remains at a high figure ranging from 1*s.* to 1*s.* 3*d.* per lb. according to the quality and colour of the seed.

General.—The information obtained from leading firms of merchants, brokers and consumers suggests that no great increase in the demand for annatto is expected by the trade in consequence of the proposed new regulations of the Ministry of Health, but the possibility of marketing a cultivated crop earlier than the wild crop may be worth consideration.

A sample consignment of 10 cwts. of seed produced from a cultivated plot at the Government Experimental Plantation, Serdang, will shortly be forwarded home, and, with the object of finding the most suitable market, it is hoped that it will be possible in future to make regular quarterly shipments of about this size.—B. Bunting, in *The Malayan Agricultural Journal*, Vol. XIII, No. 10.

IX

FUNGUS PESTS.

By Sir Arthur E Shipley, C.B.E., F.R.S.

All animals are ultimately dependent on plants, for plants build up the foodstuffs necessary for the life of animals. Hence anything that interferes with the life of plants ultimately reacts on the animals The two great enemies of plants are insects and fungi. We dealt a few weeks ago with the efforts this country is making to control the insect pests of the Empire. The Imperial Bureau of Entomology, which grapples with injurious insects, has its counter part in the Imperial Bureau of Mycology, a younger organization, but equally effective in helping to control the fungus pests of our Colonies. Under the able direction of Dr. E. J. Butler the Bureau was inaugurated in 1920, and like the parallel institution, it is financed by contributions from the various Colonies whose troubles it seeks to solve.

Fungi are those plants which are colourless; they have no green chlorophyl within them, and it is green substance which enables the higher plants to build up, under the influence of sunlight, the starches and sugars which ultimately form our food. Having no chlorophyl, fungi cannot use the energy of the sun, hence they have to adopt another method of life. They either live as parasites on other living plants or animals or they live on decaying matter. In either case they derive their energy by breaking up highly complex substances and, when these are broken up in the living plant, the living plant suffers. Many fungi, such as the bacteria, are microscopic, quite invisible to the naked eye; others however, form visible growths; from moulds and mildews to the mushroom they increase in size and conspicuousness.

But we must be just even to a fungus. All fungi are not bad. Many of them perform useful and even beneficent functons. Yeast, for instance, converts sugary solutions into alcohol. Yeasts are everywhere and the various vintage wines are, to some extent, due to the particular yeast which is found amongst the grapes. Other fungi (bacteria) help one to digest. The flavour of butter and cheese and tobacco is dependent on bacteria, and they take a large part in the preparation of flax, hemp, and indigo. In fact, we cannot get on without them, though in many cases we cannot get on with them, for they are one of the most potent causes of disease. But on the whole, fungi do more harm than good and the work of combating them, which is part of the work of the Bureau of Mycology, is of the utmost importance.

At the beginning of this century there was, I understand, one Government plant pathologist in the whole of our far-flung Empire overseas; now there are nearly 100 of these medical officers of plant diseases scattered throughout the Colonies and Commonwealths. In old settled countries, the plant and its enemies have come to a sort of understanding with one another. The host has in Lankester's term become "tolerant" of the parasite, but the introduction of new plants into new areas is almost always followed by severe outbreaks of fungoid disease. In Australia, for instance, nearly all the economic plants are exotics; introduced into new lands they meet new pests and the old pests are frequently introduced with them, or find their way in afterwards. In its new conditions of soil, climate, etc., the plant becomes unsettled and falls an easy prey to its enemies. The great rubber plantations in Malay States suffer from fungi which existed in the East before the rubber was brought there from the Amazon by way of Kew. Rubber left most of its indigenous enemies behind in the Amazon and acquired new ones in the East. In one respect rubber is in happy case, for it has few diseases that are carried by its seed. Cotton, on the other hand, has carried its diseases with it, for they are frequently seed-borne. An instance of this is the bacterium which causes "black arm" in the Sudan, which is seriously threatening the crops there, and is as yet but incompletely understood. Being seed-borne, this disease is apt to turn up wherever cotton is introduced, but fortunately it has not always found conditions favourable for its growth. Since the middle of the last century the world has been ransacked for plants of economic value, and they are being carried about wherever there is a demand for them. The numerous botanic gardens and agricultural departments which now exist are another cause of the dispersion by human agency of plants; but with the plants go their diseases, and in the last 75 years troubles which were once localized have become

worldwide. Strict quarantine is now applied to plants. It is far more difficult to get a plant into the United States than a case of whisky.

It has been known for a long time that the rust of wheat lives part of its life on the barberry and part of its life on the wheat. When the barberry is exterminated the rust cannot live, and the rust has been completely eliminated in Denmark by the removal of the last-named plant, whereas in South Wales, where the barberry occurs extensively, the disease in 1919 caused a loss of 50 per cent of the crop in many places. A similar alternation of rust occurs in the "blister" rust. This fungus passes part of its life on the black currant or other species of *Ribes*, and part of its life on the valuable pine trees of British Columbia and North-Western States. It was only introduced into America some 15 or 20 years ago, but it has taken firm hold of the country and many of the States have passed laws for the compulsory eradication of all dangerous species of *Ribes*. Without these currant bushes the fungus cannot exist and cannot pass on to the pipe. By a self-sacrificing ordinance the American Nurserymen's Association have decided at a recent meeting to "outlaw" the black currant and all its relatives in order to save the trees; but, after all, the self-sacrifice is not so very great, for it is a curious and interesting fact that one seldom sees currant or gooseberries on the other side of the Atlantic.

The whole subject is immensely important. Rubber in Malaya, tea in India and Ceylon, cocoa in the West Indies and in the Gold Coast, cotton, rice, and oil-seeds in India, wheat and fruit in Canada and Australia, all represent interests of the greatest magnitude and of the utmost importance to the prosperity of the producing country. To give a few statistics the enormous loss of value caused by plant table, taken from the plant-disease survey of the United States in 1919:—

The diseases destroyed, amongst the five leading cereals, 482,695,000 bushels.

Potatoes lost, 86,997,000 bushels.

Sweet potatoes, 58,841,000 bushels, more than half the crop.

The United States could have doubled its supply of oats to the Allies in 1917 had it not been for the losses caused by "oat smut"—an easily preventible disease. These fungoid diseases spread from plant to plant through a corn area with incredible quickness, as Hamlet says of his deplorable uncle, "like a mildewed ear, blasting his wholesome brother". In 1916 Canada lost about 100,000,000 bushels of grain of one kind and another, worth between £25,000,000 and £50,000,000.

Owing to a fungoid disease Ceylon coffee fell off from 850,000 cwt. in 1870 to 176,000 cwt. in 1884. The loss on wheat in India is put at

£3,000,000 per annum. whilst in Bombay alone the loss due to smut of sorghum, a staple food grain, amounts to £2,000,000 a year. This is fortunately seed-borne and can now be arrested by steeping the seeds in a solution of copper sulphate, and complete protection has been established at a cost of less than 1*d.* an acre. The citrus canker, which affects the citrus fruit of South Africa, was probably introduced from Japan 20 years since. Eight years ago attempts were made to control it, and in the intervening 7 years, and at a cost of £117,000, the eradication has been successfully achieved. The last case was seen over 3 years ago, although it has recently turned up again when oranges were planted on infected land. This shows that the disease can remain at least for 6 years in the soil after the removal of the infected trees.

Dealing with sick plants is a much more difficult matter than with sick persons. You cannot look at their tongue or, feel their pulse, or listen to their heart and lungs ; you cannot thump them about and say, "Do you feel anything here ?"—but you can take their temperature, and, although this was only first done two or three years ago, taking it showed that oranges and lemons suffering from fungoid disease had risen in temperature by 1½ degrees to 2 degrees F. It is quite natural but it should be so, for the presence of infective germs produces fever. The oxidation is increased.

One of the most devastating diseases is that known as the Panama banana disease. Eighteen months ago I travelled over miles of derelict land in Costa Rica which was once bearing flourishing banana plantations. In Panama one saw the same thing ; in a few years 15,000 to 20,000 acres had been abandoned. The capital loss in five years was estimated at $2,000,000, and plantations are now waste ground. Infected land retains the spores of the infective fungi for a very long time ; even a period of ten or twenty years with no bananas growing on it does not free the ground. This Panama disease is established in the Canary Islands, and is said to have been recently discovered in *the Gold Coast. Should it establish itself in Africa, as it has done in Central America, the outlook is very gloomy.—*The Times.—The Tropical Agriculture*, Vol. II, No. 12.

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*With reference to the statement made above to the effect that the Panama disease of bananas has been discovered in the Gold Coast, we are asked by the author to state that the reference should be to Sierra Leone. The Panama disease occurs in Sierra Leone but its presence in the Gold Coast has not yet been determined. [Ed., *T.A.*]

X

Research Work on the Soil during the last Twenty Five Years.

By Sir E. J. Russell, F.R.S., D.Sc.,

Director, Rothamsted Experimental Station.

During the past twenty-five years much has been learnt about the soil, and there have been improvements in practice, but they have been of more importance to farmers abroad, especially to the "dry farmers" or to men working under irrigation or alkali conditions than to farmers at home. The things that have been discovered have not yet found much practical application in this country, although beginnings have been made which may grow to be of great value in the future. They have already proved very useful to experts, and have given a degree of certainty to modern agricultural advice which saves the farmer much disappointment and financial loss.

Soil Organisms.—Perhaps the most remarkable soil discoveries of the last twenty-five years have been connected with the minute creatures living in the soil. It was known forty years ago that these living things were makers of plant food in the soil, and that plant growth depended on their activities, but little was known with certainty about the way they lived or how they could be made to do more work. Farmers were advised to encourage their activity, but no certain way of doing it was known.

The first serious attempts to utilize the soil bacteria were the inoculations of clover and other leguminous plants. All these crops bear nodules on their roots, which, when cut open and examined under a microscope, are found to be full of bacteria. Experiments showed that the bacteria are fed by the plant, and in return they fix some of the gaseous nitrogen from the air and convert it into nitrogenous food of great value to the plant. Some brilliant person conceived the idea that he would greatly increase the growth of leguminous crops if he obtained cultures of the organisms and spread them about in the soil or on the seed. The tests made in pot experiments were very successful, especially when they were carried out in sterile sand; inoculation with bacteria was followed by big increases in yield and enthusiastic writers in the Press saw visions of great achievements at little expense. One individual even went so far as to declare that inoculation would enable large areas of sandy wastes in England to be reclaimed and made fertile at a cost of six pence per acre. Many trials were made with clover, peas, beans, etc., but the increased crops and increased wealth were like the pot of gold at the end of the rainbow, and farmers in this country remained sceptical about the whole process.

On the Continent, however, and especially in Scandinavia, better results were obtained. The experimenters there had worked with lucerne and obtained more vigorous seedlings and considerable increase in crops, not indeed, every time, but so often that it was worth the farmer's while to inoculate on the chance that he would benefit. Lucerne had not been much studied by the English investigators, although the crop is well known in this country, and, indeed, in days gone by Continental agriculturists had come here to learn about it. The method of inoculating lucerne was first worked out in Denmark and Sweden, and it proved so successful that now-a-days farmers in these countries regularly adopt it as part of their ordinary cultivation. There are, of course, failures from various causes, but many successes are obtained, and the value of a good stand of lucerne is so great that all possible ways of ensuring it are worth adopting.

In the last few years considerable improvements in the process have been introduced by Mr. H. G. Thorton, of the Rothamsted Laboratory. He showed how to keep the organisms vigorous during their journey from the laboratory to the farm, and also how to ensure that they would easily move about in the soil and so infect the lucerne root. The farmer's part of the process is simple and very easily carried out on any ordinary farm. The Royal Agricultural Society has shown a keen interest in the work, and provides funds by means of which extension trials are carried out in various parts of the country to discover how far lucerne is improved by inoculation, and whether the improved crop is of sufficient value to the farmer to justify him in growing it. The work is still in progress, but already inoculation has proved of value in new districts where lucerne had not previously been grown ; the plants from untreated seed come up looking yellow and sickly, while those from inoculated seed are green, healthy, and vigorous. There remain many practical problems to be solved. Weeds are perhaps the greatest difficulty in lucerne growing in the Midlands and southern parts of England, and methods have still to be devised for keeping them down. The dying of the plants in winter causes much trouble in the north, but this will be met by introducing hardier varieties such as the Grimm and other sorts.

Glass House Soils.—Another practical application of the results of researches into the ways of the soil micro-organisms is made in glass houses, though it has not yet got so far as the ordinary farm. It was found that the useful activities of the soil organisms were increased by killing some of them. Heating the soil or treating with poisons that could afterwards be removed, brought about an increase in the number of organisms, an increased production of plant food and an increased crop yield ;

at the same time it killed disease organisms, and pests. These effects are so valuable that tomato and cucumber growers under glass find them worth paying for. The gross receipts from this form of culture may be as much as £2,000 or more per acre, so that the growers can afford to spend something to secure higher yields. The method adopted is to steam the soil, which may cost £150 or £200 per acre, or to treat it with various chemicals. Carbolic acid is popular, but other and more effective agents are now being made at Rothamsted, some of which when used at the rate of 2 cwt. per acre have added £200 or more to the gross receipts. There remains, of course, a big step from the glass house to the farm, but experiments are cheapening the process.

Soil Acidity.—Another soil subject that has been much studied is sourness or acidity. It has long been known that sour soils could be made sweet by adding lime, limestone, or chalk, but for obvious reasons no farmer can afford to add more than is necessary. Twenty-five years ago no analyst could have said how much lime a sour field needed. He would probably have advised two tons per acre, and in the case of many soils the dressing would have been safe, though it might be more than was necessary. To-day, however, methods are known for ascertaining with a high degree of probability whether lime is really needed and, if so, how much. The methods are still imperfect, but in the hands of an expert they give good results, and the advice that finally reaches the farmers is tolerably trustworthy. Further, it is recognized that the different crops vary in their response to lime and it is now possible to say with a considerable degree of certainty how much lime is needed for the various crops, and what combinations of crops can be grown without addition of more lime or with the minimum addition of lime. It is not always possible to say whether grass land will respond to lime, but a reasonably sound estimate can often be made, especially in the worst cases where slag fails to act until lime is added. All this, of course, does not amount to any sensational advance in practice, but it saves the farmer from loss of money, and it ensures that the best use is being made of such lime as he is able to purchase.

Implements for Soil Cultivation.—There have been steady improvements in the knowledge of appliances of cultivation. The art of cultivation has not improved ; the old craftsmen of the last century are going, and with them has passed the perfection of workmanship that made British agriculture a model for the world to follow. Investigators are making the most of a difficult position and are trying to do two things—to improve the implements, making them do the work more cheaply and effectively, and to reduce the art of cultivation to a science so that its

processes may be stated in exact physical and engineering terms. The two lines of work are, of course, wholly distinct.

All experience shows that the greatest developments come after the reduction to exact engineering terms. The development of the motor-car is a good example ; the essential principle of the internal combustion engine is very old ; it is simply that an explosion will blow out the bottom of a jar. The application to the blowing out of a piston and so to the turning of a wheel could not come until the velocity and pressure of the explosion flame had been exactly measured, and the work required of the piston expressed in terms of energy units. When this was done the construction of the modern car became simply a matter of multitudinous improvements in detail. We might claim the motor-car as one of the greatest agents in the improvement of farming ; it has taken farmers into new parts of the country where they could see other methods ; it has enabled them to pay frequent visits to experimental farms where they could see and either adopt or reject new implements, new varieties, fertilizers, feeding stuffs, and methods and principles of farming ; it has enabled them to attend lectures far more easily than before ; and it has had far-reaching social effects which, among other things, have completely changed the character of the market day.

Confining ourselves to soil, however, the motor instrument that has been evolved in the last twenty-five years has been the tractor. It is still far from perfect, but it is steadily being improved. The machine that we now run on our farm at Rothamsted is a great advance on the older type we first had, doing its work well, and requiring only little attention from the garage mechanic. On arable land the tractor has proved its value. It enables stubble-cleaning and the autumn cultivations to be done quickly and effectively, thus keeping the land clean ; it expedites the autumn and winter ploughing, enabling the farmer, if he wishes, to sow more winter corn, and so lighten the work of the spring ; he can sow his winter corn earlier, and thus increase the certainty of his yields. All through the year it is standing by, eating nothing, ready to haul a load, to plough, to reap, to thrash, or to do a multitude of other jobs. The principle has lately been applied to a new type of cultivator, a rotary type which was long ago regarded as the ideal design by Wren Hoskyns, one of the great agriculturists of the past. In 1852 he ventured to prophesy that farmers would one day use a wholly new implement—a "formidable looking cylinder of claws reminding one at a distant view of a half-breed between a hay-treading machine and a Croskill's clod-crusher, driven by its axis as the steam paddle, the circular saw, the driving wheel of the locomotive are driven, supported by its own apparatus and abrading the soil with its

armed teeth". The particular instrument being tested at Rothamsted is the Symar, and its work is being carefully compared with the older types of instruments.

Soil Conditions, Implements and Tilth.—While there has been steady improvement in the design of implements, there has also been a great advance in the fundamental task of reducing the work of cultivation to engineering units. This work is not easily summarized, but it consists in studying the cohesion of the soil, its plasticity, friction, water relationships, and discovering how these affect the passage of the instrument and the formation of tilth. Already it has been shown how, by a simple electrical device, the passage of the plough through the soil can be facilitated, the friction being reduced. Relationships are being found between drawback pull, soil composition; outflow of water from the drains and other properties; from all this knowledge steady improvements in soil cultivation may be confidently anticipated.

The investigation of water relationships has had another effect. It is enabling the expert to give advice on drainage with much more certainty than used to be possible. The mole drain is not a new implement, for it was fully described in Dickson's book on agriculture in 1813, and it was old then; but its present form is new, and it is capable of doing good work cheaply. But the economic results depend on closely fitting the drainage scheme to the necessities of the case. It is impossible to say how much the farmer may lose, without knowing, through misfits, but misfits are inevitable unless the water relationships of the soil are fully known. The deep drainage schemes of the first part of the last century lost to the agricultural community great sums of money, certainly millions of pounds sterling, and much of the loss and suffering could have been avoided had the results of the past twenty-five years of scientific research into soil physics been available. Indiscriminate deep ploughing was another channel by which much of the farmers' money went without return at one period. Scientific research has shown when this can be safely done and when it should be avoided; it has shown also when subsoiling would be preferable. In assessing the value of scientific work due credit should be given to the savings effected by sparing the farmer the losses which his predecessors incurred through pursuing false methods which could lead only to disappointment.—*Farmer and Stock-Breeder and Agricultural Gazette*, Vol. XXXVIII, No. 1870.

XI

Implement Tillage for Irrigation.

By R. L. Page, *Manager of Cultivation, South Porto Rico Sugar Co.*

The task of introducing implement tillage into a country where this method of cultivation has never been practised, is one beset with many difficulties. In the first place, I don't believe there is a business under the sun, where inefficient work will show up to worse advantage than poor work in cultivation with implements. And the economical results of poor cultivation are equally disastrous.

Therefore, it is easy to comprehend what one has to contend with when you try to introduce this work into a country where there are no teamsters, and where none of the labourers have the slightest conception of the principle of the implement, and the *mayordomos* are very slow indeed in learning to use judgment in putting different instruments in the different fields as conditions change.

Another idea which we have not been able to impress on our *mayordomos*, is that implements should be confined to such territory as they can attend to properly, and leave the rest of the work to be attended to by hand.

Another condition that was met with here. These fields never have been cultivated by animal power, so were not layed out with the idea of accommodating this kind of work.

Also each country has its peculiar conditions that required certain implements. Some of them may be found on the market, and others have to be improvised. These are a few of the things that have to be contended with while introducing a proposition of this kind. However they are minor details, all of which may be overcome in time.

The chief questions that have to be determined are whether or not you are able to cultivate a piece of land cheaper by this method, whether you can produce more tons per acre, and whether or not you are able to make as good use of a limited water supply for irrigation.

In discussing tillage with irrigation there are two distinct propositions to consider.

One, where you have an abundance of cheap water, where the only object in cultivation is to maintain a good soil condition for the cane, and the other, where you have a very limited supply of expensive water and where the only object is to make a gallon of water reach over as much territory as possible, never pretending to give the plant all the water it wants, merely holding it up until it rains.

The former is quite simple, and there really is not much room for discussion. I have had occasion to introduce cultivation into a proposition of this kind and in many instances obtained an increase of 100 per cent in yield and a material reduction in cost.

However, with the latter, where we have a great scarcity of water and the water is very expensive, we meet with greater difficulty, and we have to proceed with more care and judgment than where water is plentiful and cheap.

As the condition of scarcity of water obtains more generally in the better cane districts in Porto Rico, I will discuss the subject under these conditions.

The primary principles of conservation of moisture in dry farming are well known to everyone, and these are the principles which have to be applied to cultivation with irrigation under these conditions, where conservation of moisture is of primary importance.

On undulating lands and in districts frequented by drought, there is no question but that the deep-furrow system is the most desirable. First, from the viewpoint of controlling the irrigation water; second, from the fact that moisture is conserved longer in a deep furrow than in a shallow furrow, or on level land, provided proper mulch is maintained.

In carrying on intensive cultivation with implements, in connection with the deep-furrow system, the problem which presents itself is the one of conserving the banks for the purpose of controlling the irrigation and at the same time keeping soil in good condition without filling up the furrow too much.

In making a study of this phase of the problem, I have come to the conclusion, that in loose land where it may be desirable to work two animals abreast, the least practical width that banks can be made is 6 feet from centre of furrows. Anything narrower than this where furrows are made with a large *bombo* (lister) with bulls or steam plows, lister or furrow machine, it is not practical to get on to the banks with an animal-drawn implement, as they are thrown up so high and steep that it is hard walking for the animals, and the implement will roll entirely too much dirt down into the furrow.

A 6 feet bank allows a furrow of sufficient depth and at the same time a bank wide enough for animals to walk on without filling the furrow with dirt and clods. In this connection I would state that where a good bank is made, as with a steam plow it is not practical to go in with cultivators, until the banks have had time to settle, or have been worked down a little either with hoes or by rains. This lessens the danger of rolling clods down on the young shoots and at the same time gives the

cane time to get up where it is not so easily disturbed by rolling dirt and clods.

There is no question, but what the continuous passing of implements work the banks down to a considerable extent, but this also takes place nearly to the same extent by the action of the rains and continuous passing of the hoe. And I find it is possible to lay the cane by with practically as good a bank by the use of animal cultivation as by use of hand implements, with the advantage that the cane is layed by with soil in a good state of tilth instead of in a hard baked condition as when no implements are used.

In districts where (for lack of land) we are forced to put our fields back in cane as soon as the crop is cut, we have considerable difficulty in getting rid of the old cane roots ; while in the *gran cultura* planting the roots have pretty well disappeared through decay and repeated plowings.

In fields where we are obliged to chop up the stumps in search of the white grub and weevil root-borer, this trouble is done away with ; and in fields not treated in this manner, where the old stumps are large and bothersome, we send men in with grub hoes and split up the larger stumps which interfere with the implements.

Implements.—After having made a study of this subject for the past four years I have decided on the following implements, which we are now using under different conditions as requirements demand.

I have devised a banking machine, and a disc cultivator with eight discs. In addition to these I use a diverse or spring-tooth cultivator, an ordinary double-shovel cultivator, and small plows.

For conservation of moisture and destruction of small weeds just as they are germinating, I use the spring-tooth cultivator, with levers set so that teeth slant back towards the centre of the bank ; this has a tendency to draw the mould away from the cane, together with any loose trash and deposit it in the centre of the bank. This is drawn by one animal, and two passes are made ; one down the right side of the bank and back on the left side. We are doing this work now at an expense of 15 cents per acre.

For the destruction of small weeds and building up the bank which may have become flattened out from any cause or other we use the banking machine which is composed of two pieces of sheet iron five feet long set on a slant, with the front ends set apart, the width of the bank and the rear end set just far enough apart to allow the mould to roll out on to the centre of the bank. This is drawn by two good mules, and as this requires only one pass, we pay 8 cents an acre for this work. We find that by

passing this implement after cultivation with other implements, we are always able to keep the banks in a satisfactory condition and never lose control of our irrigation water.

After the banker we quite often run the disc cultivator, which leaves a mulch on the sides of the bank next to the cane. When the bank comes slightly packed as a result of passing these implements, we go in after irrigation with a double-shovel cultivator and make three or four passes as the case may require, and if the bank has become very hard we go in with a small plow and break it up thoroughly, then follow up again with the banker and other implements as the case may require.

It is always desirable, after passing either the small plows or double-shovel cultivators, to pass the diverse or spring-tooth cultivator at once. By this I mean the spring tooth should be in the field at the same time as, and only two or three furrows behind, the small plow or double-shovel. This will assist materially in conservation of moisture as well as improving condition of soil.

In addition to this system of cultivation, we have introduced in the Guanica District, for the conservation of moisture, and to prevent germination weeds, the practice, after each of the first three or four irrigations of mulching, or pulverizing the irrigated surface in the bottom of the furrow, both before and after germination, with a tool known in the United States as a potatoe hook—which is a heavy rake of four or five prongs. This operation to be of any material benefit must be done soon after irrigation.

In my opinion, by this treatment of the soil we get considerably more benefit out of our irrigation water, which in the Guanica group constitutes our chief expense.

The foregoing is with refernce to our district where (1) we rely principally on our pumps for moisture, (2) where soil is principally loose loam and readily adapted to cultivation and very productive with sufficient moisture, (3) where due to pests we do not make a practice of ratooning.

In our other districts where we depend almost entirely on rain, conditions are quite different. The soil for the most part is of a stiff, clayey nature, becomes exceedingly hard immediately after rain or irrigation is not properly worked, and has always been considered rather poor in regard to productiveness. And I believe it is on these poor soils where we are deriving greatest benefits from cultivation. A large portion of these lands are farmed in *grand banks*, or in *tableta* of from three to four rows in a *tableta*. Here a greater portion of the year, conservation of moisture is *not* the chief object ; but the desired result is to maintain a

good soil condition and keep down the weeds, thereby reducing the expense.

However, in accomplishing this we find that where we are able to obtain a good soil condition or mulch before drought, the cane on these fields comes through the dry weather in good shape and makes some growth instead of drying up and dying back, as in fields not cultivated.

In these fields, where we have to pay more attention to drainage than to irrigation, we make no effort to maintain in the bank between the row, and sometimes even bank the dirt on the cane row.

Here also we are never bothered with old cane roots, as land always lies idle a few months giving roots time to rot.

In these districts we ratoon a great deal and start these off by lining trash on every other bank and plow the clean bank with as large a plow as is practical, then trasfer the transh to the plowed bank and plow the other one. In some cases where, due to floods, we are obliged to burn the trash to prevent same being piled on young cane, we go in with a 9 inch plow and three yoke of bulls or three teams of mules and offbar as deeply as possible up close to the cane row. Then we apply fertilizer and either plow this dirt back or work it back with the cultivator.

I am very much in favour of offbarring and believe it should be practised wherever possible.

In some of these poorer districts we have, through eradication of diseases, introduction of new varieties and cultivation, been able to raise our average yield in tons per acre in the past four years, from 11 and a fraction tons up to an average of 24.6 tons for the crop just finished. Just how much of this increase is to be credited to cultivation cannot be stated, but there is no question but that cultivation is entitled to a part of it.

Conditions with reference to drought, disease and pests have been so unusual during the past four years, that it has not been possible to compile any positive data regarding the actual advantage to be derived from implement cultivation ; and as conditions on different parts of the Island vary so much, anyone introducing cultivation with implements has to figure out methods which will apply to his particular conditions.

And while in many instances it may not be practical to introduce a system of intensive cultivation with implements, I am firmly of the belief that in nearly every instance, some implement can be profitably introduced.—*The Journal of the Department of Agriculture of Porto Rico*, Vol. VIII, No. 2.